4

Science Standard 4.2.c.

Teacher's Edition

California Education and the Environment Initiative

Life and Death with Decomposers

California's Environmental Principles

The State of California's Environmental Principles and Concepts were approved in 2004 under a law referred to as the California Education and the Environment Initiative (EEI). The law called for the development of Environmental Principles and Concepts that are compatible with the State's academic content standards and, as such, would become a formal part of California's K-12 education system. The EEI Curriculum, which this unit is part of, is designed to help students simultaneously achieve mastery of selected academic content standards and California's Environmental Principles and Concepts.

Principle I

People Depend on Natural Systems

The continuation and health of individual human lives
and of human communities and societies
depend on the health of the natural systems that provide essential goods
and ecosystem services.

Principle II

People Influence Natural Systems

The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems
are influenced by their relationships with human societies.

Principle III

Natural Systems Change in Ways that People Benefit from and Can Influence

Natural systems proceed through cycles

that humans depend upon, benefit from and can alter.

Principle IV

There are no Permanent or Impermeable Boundaries that Prevent Matter from Flowing Between Systems

The exchange of matter between natural systems and human societies
affects the long-term functioning of both.

Principle V

Decisions Affecting Resources and Natural Systems are Complex and Involve Many Factors

Decisions affecting resources and natural systems
are based on a wide range of considerations
and decision-making processes.

D R A F T
for discussion purposes only

California Education and the Environment Initiative

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Contents

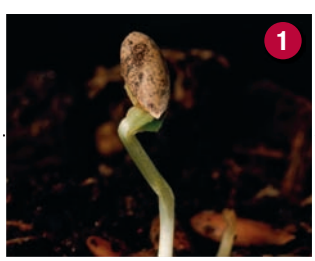
Overview

Springtails on a mushroom

Casual observers often overlook and misunderstand the roles of important microscopic organisms in every ecosystem. Although the world of **decomposers** may go unnoticed, decomposers play an essential role in the cycle of life.

This unit focuses on decomposers and their role in breaking down carbon-based **organic** matter, materials that come from living things. Only fungi and **bacteria** are correctly categorized as true decomposers. Many students know decomposers simply as "nature's recyclers." Throughout the unit, students learn that decomposers are actually part of a larger system that works to cycle chemicals such as carbon, nitrogen, water, and oxygen through complete food webs.

At a Glance



Breaking It Down
Read about composting and take part in a composting demonstration using bananas and yeast.

Decomposers and Scavengers
Examine descriptions and photographs of decomposers and scavengers and compare characteristics.

A Big Job for a Tiny Crew
Observe and discuss evidence of decomposition and the role of decomposers in ecosystems.

California Content Standard

4.2. All organisms need energy and matter to live and grow.

4.2.c. Students know decomposers, including many fungi, insects, and microorganisms, recycle matter from dead plants and animals.

California Environmental Principle III

Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.

Concept A: Students need to know that natural systems proceed through cycles and processes that are required for their functioning.

Concept B: Students need to know that human practices depend upon and benefit from the cycles and processes that operate in natural systems.

Students may already have learned that energy flows from one organism to the next in any ecosystem through food chains and food webs. In this unit, students learn that, in order for food webs to function, decomposers must help cycle nutrients in every ecosystem. Students become familiar with various decomposers, understand their roles within all ecosystems, and connect the contributions of decomposers within **natural systems** to the health and continuation of those systems. Students also identify several human practices that depend on **decomposition** and the work of decomposers; these practices include agriculture and waste management.

Lesson 1 introduces students to the relationship between decomposers and humans through a story about several Californians who use various methods for generating compost from their food scraps and then use the compost in gardens to grow more food. In Lesson 2, students identify examples of decomposers and the special relationship between **scavengers** and true decomposers. Students explore evidence of decomposition and the role decomposers play in releasing nutrients back into terrestrial and marine ecosystems in Lesson 3. Lesson 4 teaches how decomposers are essential to our system of wastewater treatment, while Lesson 5 focuses on how human food production ultimately depends on decomposers' abilities to replenish nutrients in the **topsoil**, making it more suitable for agriculture. In Lesson 6, students return to the idea of composting as a way of producing nutrient-rich **humus** to support plant growth; they also look at composting as a way to reduce organic waste that might otherwise be destined for our already-overflowing landfills. By the end of the unit, students have an appreciation for and understanding of decomposers and the essential role they play in all natural and **human social systems**.

Waste Not
Interpret a diagram showing a wastewater management system and answer questions.

Down on the Farm
Investigate and describe why decomposers and humus are essential to agriculture.

The Benefits of Composting
Discuss how composting can help communities manage waste.

Wonderful Compost

The warm days of summer turn cooler. Tree leaves shake and rustle in the wind. It is October, and crisp red apples ripen on the trees. In the fall, Juliana Kelly loves to pick apples. Her family goes to an apple orchard every year.

The orchard is in the foothills of the Sierra Nevada Mountains. Its name is Apple Hill. Juliana picks sweet, red apples and puts them in her basket. She will eat the apples in pies, as a snack, and in her school lunch.

At home, Juliana helps her mother make apple pies for the neighbors. She carefully takes the core out of each apple. All of these apple cores have to go somewhere. Juliana has some choices. She can put the apple cores in the trash. A garbage truck will pick up the trash and take it to a landfill. Juliana has another choice. She can save the apple cores for the family compost pile.

Juliana decides not to put the apple cores in the garbage. Instead, she adds them to the compost pile in her backyard. She throws the apple cores on top of the compost pile with other vegetable, fruit, and food scraps. Then she adds some grass from the lawn-mower bag. She sprinkles some rich, black soil on top.

The apple cores and the cut grass soon begin to rot. Scientists use the word "decompose" to explain what happens to the food scraps. Tiny organisms live in the pile. Bacteria and fungi change the chemistry of the

Apple tree

Apple core

food, and break it down into nutrients that enrich the soil. Chemical decomposers are tiny. People need a microscope to see them.

Mites, pill bugs, snails, and springtails live in Juliana's yard. So do beetles, ants, flies, and earthworms. They all find their way to the compost pile. These physical decomposers or scavengers grind, bite, chew, and tear the food into tiny pieces. They work with bacteria and fungi. Together they turn the food scraps into compost.

Juliana knows that the decomposers need help. They must have water, air, and lots of food to make healthy compost. Juliana sprays her compost pile with water every few days. She uses a shovel to turn the compost pile. Turning the pile gives the decomposers a fresh supply of air. She also makes sure they have lots of fresh food scraps.

The compost is ready to use in a few months. It smells and looks like rich, healthy soil. Juliana puts the new compost in her garden. She mixes it with the soil. Then she plants pumpkin seeds and tomato seeds. She waters them well. Soon she will see tiny plants begin to sprout. Juliana will watch her pumpkins and tomatoes grow. Her family will begin to eat them when summer comes. Juliana will remember her compost each time she bites into a juicy tomato.

Juliana's mother takes a fresh apple to work. After she eats her snack, she puts the apple core in a covered box. In the box are hundreds of wriggling red worms. Tiny decomposers also live in Mrs. Kelly's box.

The red worms begin to eat the apple core. Their intestines are rich with juices. These juices break down the food. The worms leave behind droppings. The name for their droppings is "castings." Tiny decomposers will break down the castings and release vitamins and minerals. These nutrients are good for plants. Mrs. Kelly will use the castings to help her garden grow.

When a worm dies in the worm box, tiny bacteria go to work. They break down the carbon, nitrogen, and protein in the worm's body. Bacteria need carbon and nitrogen for energy. They need protein to grow and

Apples in compost pile

multiply. Decomposers like bacteria leave their own waste behind. This waste is rich in nitrogen, phosphorus, and magnesium.

"Vermicomposting" *(*"vermi" means worm) is the term for what happens when worms decompose food waste. Vermicomposting is a good choice for people who want to compost but do not have a big backyard. A box of special red worms takes little space. People can buy the worms online or at a local nursery. The worms need bedding like shredded newspaper. They need a steady supply of food scraps. They need someone to make sure their home doesn't get too wet or too dry. Many classrooms have worm bins. Sometimes students put the castings in their school gardens. Other students take the castings home for their houseplants.

Lucas Garcia is a young boy who lives in Alameda, a town near San Francisco. He does not have a garden. But he knows how to use his family's food scraps for compost. Lucas reminds his family to put their food waste in a special bucket by the sink. When it is full, he dumps it into a green waste cart outside the house. Mrs. Garcia puts grass into the green waste cart after she mows the lawn.

Each week Lucas pushes the green cart to the street. A special green truck picks up the Garcias' green waste. The truck stops at every house in Alameda. The green waste goes to one big composting place. There, decomposers and scavengers turn the waste into compost. Other cities send their green waste to the same place. California has so much green waste that it creates 4 million tons of compost each year.

Farms, vineyards, and orchards use the compost that Lucas helps the city make. Farmers in the Central Valley, Napa Valley, and Sonoma Valley add compost to their soil. They add compost to orange, avocado, and almond trees. Compost also helps grapes, tomatoes, and other crops. Farmers who use compost can water less. They can also cut back on use of chemical fertilizers, which can sometimes pollute the environment and make animals sick. Compost makes the soil and plants healthier. Using compost is good for farmers. It is also good for our land, food, and water.

Making compost means putting less in the garbage can. Less trash means fewer garbage trucks. This means less traffic and pollution. Less traffic and pollution can mean better air to breathe. Landfills will fill more slowly if people make less trash. Many landfills are built on open space that provides habitat for wild animals. When new landfills are built, habitat for animals is often destroyed. Finding new places to take our garbage is very difficult. Every person in California makes about 58 pounds of trash each month. You probably already recycle bottles, cans, and paper. How much less trash would you make if you made compost?

Juliana and Lucas feel good about composting their food waste. They use what some would call garbage to make soil healthier. They know that making compost with the help of decomposers is an important step. Their families and their friends can enjoy healthy food and safe water. Food grown in composted soil can improve the quality of life for all.

Red worms feeding

Teacher's Background

Leaves and mushrooms on forest floor

Earth's **biodiversity** is amazing. The fact that scientists have identified more than 1.5 million species and estimate that there are millions more provides evidence of that biodiversity. Isolated, these species could not survive, but together with Earth's non-living components, such as carbon, nitrogen, oxygen, minerals in soil, and water, they make up the **natural system**.

In natural systems, living and non-living components participate in and influence such processes and cycles as energy transfer and conversion, the water and nitrogen cycle, and reproduction. Removing or changing any one component in a natural system can influence the cycles or processes that are necessary for its functioning. Exploring the components within natural systems and the connections among their functions enables students to understand that, as human beings, they are not isolated from natural systems. Humans are a part of these systems and depend on the systems' processes and cycles for food to eat, water to drink, and air to breathe.

One important process in every natural system is **decomposition**. Decomposition is the breaking down of matter into its smallest components, chemical elements. A decomposer is an organism that participates in that process somehow, breaking down organic matter that once was living. Some organisms simply consume "dead" matter and transform it from solid to liquid in their waste, while other organisms use enzymes to digest organic matter, such as leaf litter and animal waste, chemically, thereby releasing the essential nutrients trapped inside.

The two categories of living things that participate in decomposition do so in distinct ways. The first type of organism is a scavenger. Scavengers participate in the decomposition process, but they are not "true" decomposers, as they do not break down material into its

simplest chemical elements. Through their feeding process and physical digestion, scavengers break down material into smaller pieces for "true" decomposers to work on. Worms, pill bugs, springtails, maggots, and turkey vultures are examples of scavengers.

The true decomposers in the natural system are **fungi** and **bacteria**. Bacteria are microorganisms invisible to the naked eye. In fact, many bacteria are so small that 1,000 could fit on a pinhead. Most are single-celled organisms that need to eat as other consumers do; however, they lack the classic parts of the digestive system that other living things have—a mouth, stomach, or intestines. Bacteria absorb nutrients through pores in their cell walls. In order to do this, they, like fungi, must come into direct contact with their "food." Fungi attach themselves to and grow on the surface of living and non-living things. To obtain the nutrients they need, they first secrete enzymes onto the organic material they are "eating." These enzymes begin to break down the organic matter. The fungi then absorb the nutrients from the matter through their *mycelium* or filamentous (hair-like) parts.

The "partnership" between scavengers and true decomposers makes the process of decomposition extremely efficient. True decomposers can only absorb the smallest components of organic matter, and they have a much easier time doing so when the matter is in small pieces. This works on several levels. When an animal or plant dies or part of a plant breaks off from the main part of the plant (a leaf or limb off a tree, for example), scavengers bite, grind, chew, and tear the material into pieces, exposing much more surface area of the "dead" matter on which the true decomposers can work. Additionally, true decomposers feed on the solid wastes excreted by scavengers after they have eaten the "dead" matter. That waste contains many of the nutrients locked up in the original "dead" matter, but the decomposers present in the digestive systems of scavengers (and all consumers) have broken down those nutrients. There are even some scavengers that prefer their "meal" be partially broken down and softened by bacteria and fungi before they eat it. While the decomposition process might be possible without scavengers, it would be absolutely impossible without the true decomposers. But the partnership these organisms have forged increases the speed at which the process moves, which increases the benefits to natural and human social systems.

The "decomposition team" of true decomposers and scavengers serves ecosystems in three important ways. First, decomposers are present on all levels of the food web. Because decomposers live everywhere, including inside and on many other organisms, consumers and scavengers eat them, either directly as a preferred food source or indirectly when one consumer eats another consumer or a producer. For example, as an earthworm tunnels and burrows through soil, it swallows plant scraps as well as decomposing microorganisms living in the soil. Later a bird, lizard, or mole might eat that same earthworm. In this way, decomposers form a vital link in all food chains.

Second, decomposers act as a "cleanup crew"" for the natural system by breaking down dead matter and wastes, converting them to useful nutrients and chemical elements and making them accessible to other

Turkey vulture

Estuary near Ventura, California

living things. Imagine if, year after year, all the fallen leaves, animal carcasses, and solid wastes remained intact on Earth's surface. As organisms on our planet have been living and dying, eating and excreting wastes for over 3.5 billion years, by now dead debris would cover Earth, leaving no space for the living. By breaking down dead matter and wastes, the decomposition team of scavengers and decomposers helps the natural system and human communities manage "waste."

Third, the actions of the decomposition team form a critical stage in the **nutrient cycle**. Nutrients are the chemical building blocks that give all living things the matter and energy to grow and reproduce. For most animals, proteins, carbohydrates, and water comprise these nutrients. The work of decomposers makes these nutrients available in the soil, in the air, and in the water and helps organisms unlock the power of these nutrients.

All organic matter contains nutrients in tissue. As decomposers feed on organic matter, they convert tissue into smaller, simpler chemicals, releasing chemicals like carbon, nitrogen, and water into the surrounding environment. Without decomposers, these nutrients would remain locked up in tissue and in animal wastes. Once water and nitrogen are in the air and soil, plants absorb them and use them in photosynthesis. The plants either become a source of food or produce food for consumers, including scavengers. The process of breaking down matter and making the chemicals contained therein available allows the nutrient cycle to continue.

All Earth's ecosystems have a similar reliance on the nutrient cycle and, therefore, on decomposition. Terrestrial, aquatic, and marine ecosystems all depend on decomposers as key components serving the same roles. An absence of decomposers in any ecosystem has serious implications for all other living things in the ecosystem. Even human agricultural practices and waste management systems ultimately depend on the work of decomposers.

In California, coastal estuaries have supported the growth and development of human communities and economies. An estuary is an area where the fresh water from rivers meets and mixes with salt water from the ocean, often located in bays or other inlets. Coastal estuaries exist throughout California. Examples include the San Francisco Estuary, Morro Bay, and Upper Newport Bay.

Due to a high inflow of plant matter from rivers, decomposers thrive in coastal estuaries. The decomposers break down the plant matter and release nutrients back into the aquatic ecosystem. The nutrient-rich soils and waters that result from the work of decomposers provide nutrients to all the producers in the estuary ecosystem: phytoplankton and algae, cordgrass, eel grass, and other estuarine plants. These plants supply food and shelter for a variety of fish, from herring to halibut, and marine invertebrates, such as Dungeness crab. The fish provide food for other animals, including humans. In fact, approximately 75 percent of all commercially harvested fish lived in an estuary at some point in their life cycle. Hence, the commercial fishing industry relies on healthy coastal estuaries, which in turn rely on decomposers to maintain their amazing productivity.

Importantly, coastal estuaries can also remove pollutants from water and soil. Decomposers and the plants they support within estuaries filter out high loads of nutrients and toxic byproducts of wastewater and runoff carried in from upland cities and agricultural fields. Bacteria in estuaries can tolerate substances that would kill other organisms. In the case of some of these dangerous toxins, decomposers, through their metabolic processes, can remove many organic compounds found in municipal wastewater and stormwater runoff. With the more harmful compounds broken down, estuary plants are then

able to absorb the remaining contaminants as water flushes through the estuary on its way to the ocean.

California's agricultural economy would not be possible without decomposers. Rich topsoil is an ecosystem good that is a very important component of the rich soils that California's farmers have relied upon for 200 years. Not all topsoil is the same. Topsoil's organic content, called humus, affects the quality of the topsoil. Humus is organic material in the very last stage of decomposition. Decomposers get the organic material to this stage. When properly mixed with inorganic sediments, humus:

- provides the essential nutrients required by growing plants
- creates space in the soil for gases and water sought by plant roots
- controls pH levels to keep soil from becoming too acidic or too alkaline
- absorbs heat, which creates better germinating conditions for seeds

Without decomposers, there would be no humus, making human agriculture next to impossible.

The amount of topsoil on the planet suitable for growing food is limited. Topsoil can be lost through erosion or depleted of nutrients through overuse. The United States loses 1.7 billion tons of topsoil to erosion every year. As farmlands become less **fertile** due to over-farming, more gardeners and commercial farmers are turning to composting. Composting is simply a controlled process that encourages decomposition in a contained environment. The benefits of composting are threefold. Composting capitalizes on decomposers' ability to build fertile soil, it takes advantage of decomposers' ability to break down matter, and it keeps organic waste out of the landfills. In fact, many municipalities in California have turned to composting as a means of managing their solid waste while also producing soil enhancers.

For the many reasons discussed here, decomposers are essential, not only to natural systems, but also to human practices such as food production and waste management.

Farm crops

Glossary

Bacteria: Microscopic, one-celled organisms that play a key role in decomposition.

Biodiversity (biological diversity): The variety of life over some spatial unit, used to describe all aspects of the broadly diverse forms into which organisms have evolved, especially species richness, ecosystem, complexity, and genetic variation.

Decomposer: An organism, such as a bacterium or fungus, that breaks down organic matter into its chemical and mineral components.

Decomposition: The breaking down of organic matter into its chemical and mineral components.

Fertile (land): Pertaining to soil that produces abundant plant growth because it is rich in nutrients.

Fungus: An organism such as a mushroom that lacks chlorophyll and obtains energy and matter primarily from dead organic matter.

Human Social Systems: The basic constructs, functions, and interactions within and between human communities and societies.

Humus: The dark brown or black layer in soil that consists of decayed organic matter. Humus increases soil fertility and water retention.

Natural System: The interacting and/or interdependent components, processes, cycles, and interactions among organisms and their habitats.

Nutrient Cycle: The cycling of a chemical element, such as nitrogen, through the environment.

Organic: Containing carbon compounds, as in relating to or derived from living organisms.

Scavenger: An animal such as a vulture or earthworm that obtains energy and matter by eating dead organisms.

Topsoil: The upper layer of soil, characterized by a higher content of organic matter.

Unit Planner

	Lesson	Learning Objective(s)	At a Glance
1	**Breaking It Down** **Preparation Time:** 45 min. **Instructional Time:** 50 min.	■ Give examples of organisms that are decomposers. ■ Provide examples of human practices that directly depend on the cycles and processes involving decomposers in terrestrial, freshwater, coastal, and marine ecosystems (e.g., their role in food production and waste management).	Students read a story about three approaches to composting, identify the decomposers in the described compost bins, and diagram the food chains represented. They set up a composting lab using bananas and yeast, and make predictions about the decomposition process.
2	**Decomposers and Scavengers** **Preparation Time:** 20 min. **Instructional Time:** 50 min.	■ Give examples of organisms that are decomposers. ■ Explain the role of decomposers in an ecosystem.	Students match descriptions of decomposers and scavengers to the pictures and names of actual organisms. They compare characteristics of decomposers to those of scavengers. Using clues, students identify examples of decomposers and scavengers on photo cards.
3	**A Big Job for a Tiny Crew** **Preparation Time:** 30 min. **Instructional Time:** 50 min.	■ Explain the role of decomposers in an ecosystem. ■ Recognize that the cycles and processes involving recycling of matter and transfer of energy among organisms are essential to the functioning of natural systems (ecosystems).	Students observe evidence of decomposition and apply this concept in a discussion about the role of decomposers in ecosystems. They listen to two narratives describing decomposition and create diagrams showing decomposers and scavengers in the food web.
4	**Waste Not** **Preparation Time:** 15 min. **Instructional Time:** 50 min.	■ Provide examples of human practices that directly depend on the cycles and processes involving decomposers in terrestrial, freshwater, coastal, and marine ecosystems (e.g., their role in food production and waste management). ■ Describe the dependence of human practices on the cycles and processes that occur in terrestrial, freshwater, coastal, and marine ecosystems (e.g., the role of decomposers in: food production through soil formation and fertility; waste management through the decay of waste products).	Students interpret a diagram showing a wastewater management system. They discuss the presence of particular organisms that help decompose matter in the system. Students answer questions about the waste management system and humans' dependence on decomposers to make the system work.

Prerequisite Knowledge

Students should know about:
- What plants need to survive.
- The basic components of soil.
- Food chains and food webs.

Students should be able to:
- Identify producers and consumers within food chains.
- Generate a reasonable prediction based on prior knowledge or experience.
- Use a gram scale to determine the weight of an object.

Students should have:
- Completed previous lesson.

Students should be able to:
- Identify characters and events in a story and use a graphic organizer to illustrate the connection between them.

Students should have:
- Completed previous lessons.

All Materials Needed

Lesson Toolboxes identify lesson-specific needs.

Activity Supplies:
- Bananas: four per class, ripe
- Dry active yeast: four packets per class
- Knife: one per class
- Paper towels: one roll
- Self-sealing plastic bags: two per group of four students, plus one extra for the teacher
- Teaspoons: one per group of four students
- Trays (optional): one per group of four students
- Butcher paper: one six-foot sheet per class (light color)
- Apple: One per class
- Buckets: Two per class, 1 gallon or bigger
- Cups: One per student, at least 16 ounces
- Index cards: Two
- Magnifying glass: One per student
- Measuring cups: Two half-cup measuring cups
- Potting soil: Ten cups of potting soil with high organic content
- Sand: Ten cups of hygienic sandbox sand

A-V equipment:
- Overhead or LCD projector, screen

Class supplies:
- Chart paper (optional), colored pencils, markers, masking tape, pencils, stapler, staples, transparency markers

Textbook Alignment

Houghton Mifflin: Unit B Ch.4: 114-127, 1134-137, 143, 146

Macmillan/ McGraw-Hill: Pages 36, 38, 62, 64-69

Harcourt: Pages 166-177

TPS: TE pages 133-146

FOSS: Environments: Investigation 3 Part 3-4 pages 136-150, Investigation 4 Part 3 pages 181-186

Unit Planner

	Lesson	Learning Objective(s)	At a Glance
5	**Down on the Farm** **Preparation Time:** 30 min. **Instructional Time:** 50 min.	■ Provide examples of human practices that directly depend on the cycles and processes involving decomposers in terrestrial, freshwater, coastal, and marine ecosystems (e.g., their role in food production and waste management). ■ Describe the dependence of human practices on the cycles and processes that occur in terrestrial, freshwater, coastal, and marine ecosystems (e.g., the role of decomposers in: food production through soil formation and fertility; waste management through the decay of waste products).	Students learn what humus is and that decomposers form humus as they break down dead organisms. They investigate different soil types and observe the amount of humus in topsoil. They apply their observations to describing why decomposers and humus are essential to agriculture.
6	**The Benefits of Composting** **Preparation Time:** 15 min. **Instructional Time:** 50 min.	■ Provide examples of human practices that directly depend on the cycles and processes involving decomposers in terrestrial, freshwater, coastal, and marine ecosystems (e.g., their role in food production and waste management). ■ Describe the dependence of human practices on the cycles and processes that occur in terrestrial, freshwater, coastal, and marine ecosystems (e.g., the role of decomposers in: food production through soil formation and fertility; waste management through the decay of waste products).	Students revisit the composting lab, observing what has happened since they placed the materials in the bags. They reread ***Wonderful Compost*** and discuss how composting can help California communities manage waste and maintain the health of topsoil used to grow food.

Prerequisite Knowledge	All Materials Needed	Textbook Alignment
Students should be able to: ■ Record simple observations and data. **Students should be able to:** ■ Explain that plants are the source of all foods. ■ Explain that soil is made partly from organic materials and that sandy and clay soils differ in color, texture, capacity to retain water, and ability to support the growth of many kinds of plants. ■ State that plants need water and nutrients to grow.		
Students should be able to: ■ Record observations and data.		

English Language Development

Lessons in the EEI Curriculum are designed to support students' English language development. The strategies in these lessons are based on some of the practices identified in the Reading/Language Arts Framework for California Public Schools (California Department of Education 2007) and ideas adapted from the San Joaquin County Office of Education's Regional Technical Assistance Center.

To establish successful instructional strategies for all students, the teacher should:

- **Use a wide variety of ways to explain a concept or assignment.** When appropriate, the concept or assignment may be depicted in graphic or pictorial form, with manipulatives, or with real objects to accompany oral and written instructions.

- **Provide assistance in the specific and general vocabulary** prior to the each lesson, using reinforcement and additional practice afterward. Instructional resources and instruction should be monitored for ambiguities and language that could be confusing to students, such as idioms.

- **Ask each student frequently to communicate** his or her understanding of the concept or assignment. Students should be asked to verbalize or write down what they know, thereby providing immediate insight into their thinking and level of understanding. In addition, students should be encouraged to confer about each other's understanding of the concept being taught and the classwork or homework assignments, particularly if the students are not fully proficient in English.

- **Check frequently for understanding in a variety of ways.** When a student does not understand, analyze why.

- **Allow students to demonstrate their understanding and abilities** in a variety of ways while reinforcing modes of communication that are used on standardized tests.

- **Use pacing to differentiate instruction according to students' needs.** Reinforce the more difficult concepts for students experiencing difficulty in the language arts by providing additional time and using the visual aids provided. Accelerate the instructional pace for advanced learners if the assessments indicate mastery of the standard.

The California EEI Curriculum includes a variety of research-based English language development practices, such as:

Vocabulary Development

- Teach difficult vocabulary prior to and during the lesson
- Provide reading, speaking, and assessment tasks that reinforce new vocabulary

Reading Comprehension

- Use grade-level readers, articles, and reading assignments to build comprehension in the content area
- Engage students in meaningful interactions about text
- Provide activities that assess student comprehension and build decoding skills

Writing Strategies and Applications

- Provide opportunities for students to organize ideas and information in a written form including concept maps
- Use stories, articles and other written materials to model good writing
- Provide assessment tasks that allow students to apply their grade-level writing skills

Listening and Speaking Strategies and Applications

- Ask questions to ensure comprehension
- Elicit responses from all students, encourage students to give elaborate responses, and give students time to respond to questions
- Incorporate students' responses, ideas, examples, and experiences into the lesson
- Model and teach language patterns needed to understand and participate in the study of the content areas
- Encourage a high level of response accuracy
- Use visual aids, manipulatives, and real objects to support content delivery

The lessons in this unit can be used to support a variety of English language arts skills. This matrix summarizes how each of the lessons can be used to support English language development.

	V Vocabulary	R Reading	W Writing	L Listening	S Speaking
Lesson 1	✓	✓	✓	✓	✓
Lesson 2	✓	✓	✓	✓	✓
Lesson 3	✓	✓		✓	✓
Lesson 4	✓	✓	✓	✓	✓
Lesson 5	✓	✓	✓	✓	✓
Lesson 6	✓	✓	✓	✓	✓

Differentiated Instruction

The 2007 Reading/Language Arts Framework for California Public Schools (California Department of Education 2007) provides guidance for helping students with diverse abilities succeed with California's English–Language Arts Content Standards. The instructional units developed for California's Education and the Environment Initiative provide ample opportunities for teachers to differentiate instruction to meet these needs.

It is important to take into account the State Board of Education's and Department of Education's guidance on differentiated instruction while implementing this instructional unit. Page 263 of the 2007 Framework summarizes this guidance as follows:

The diversity of California's students presents unique opportunities and significant challenges for instruction. Students come to school with a wide variety of skills, abilities, and interests as well as varying proficiency in English and other languages. The wider the variation of the student population in each classroom, the more complex becomes the teacher's role in organizing high-quality curriculum and instruction in the language arts and ensuring that each student has access according to the student's current level of achievement. The ultimate goal of language arts programs in California is to ensure access to high-quality curriculum and instruction for all students in order to meet or exceed the state's English–language arts content standards. To reach that goal, teachers need assistance in assessing and using the results of that assessment for planning programs, differentiating curriculum and instruction, using grouping strategies effectively, and implementing other strategies for meeting the needs of students with reading difficulties, students with disabilities, advanced learners, English learners, and students with combinations of special instructional needs.

Procedures that may be useful in planning for universal access are to:

- *Assess each student's understanding at the start of instruction and continue to do so frequently as instruction advances, using the results of assessment for program placement and planning.*
- *Diagnose the nature and severity of the student's difficulty and modify curriculum and instruction accordingly when students have trouble with the language arts.*
- *Engage in careful organization of resources and instruction and planning to adapt to individual needs. A variety of good teaching strategies that can be used according to the situation should be prepared.*
- *Differentiate when necessary as to depth, complexity, novelty, or pacing and focus on the language arts standards and the key concepts within the standards that students must master to move on to the next grade level.*
- *Employ flexible grouping strategies according to the students' needs and achievement and the instructional tasks presented.*
- *Enlist help from others, such as reading specialists, special education specialists, parents, aides, other teachers, community members, administrators, counselors, and diagnosticians when necessary and explore technology or other instructional devices or instructional materials, such as braille text, as a way to respond to students' individual needs.*

Additional information about best practices in differentiated instruction are detailed in Chapter 7 of the Framework.

Traditional Unit Assessment

Description

Life and Death with Decomposers (Traditional Unit Assessment Master) tests student understanding of decomposers' roles in ecosystems and human dependence on decomposers and the process of decomposition. Questions 1, 2, 3, 5, and 6 demonstrate that students can define "decomposer" and provide examples of decomposers. Questions 3, 5, and 6 demonstrate students' comprehension of roles decomposers play in ecosystems. Questions 7, 8, 9, 11, and 12 assess whether students can provide examples of human practices dependent on decomposers. Questions 12 assess student understanding of how human practices depend on decomposers.

Advanced Preparation

Gather and prepare Assessment Masters.

Suggested Scoring

Use the Answer Key provided on pages 22–24. The total possible score is 19 points.

Preparation Time

10 min.

Assessment Time

45 min.

Life and Death with Decomposers

Traditional Unit Assessment Master | *page 1 of 3*

Name: _____

Multiple Choice: Select the best answer and circle the correct letter. (1 point each)

1. Which three are decomposers?
   a. earthworm, fungi, bacteria
   (b.) bacteria, yeast, mold
   c. scavenger, mold, sow bug

2. Living things that use chemicals to break down matter are called
   (a.) decomposers
   b. scavengers
   c. consumers

3. Decomposers in food chains
   a. are eaten by other consumers
   b. feed on dead plants and animal matter
   (c.) both a and b

4. How do decomposers help humans grow food?
   a. they release nutrients into the soil and make humus.
   b. they clean-up waste.
   (c.) both a and b

5. What would happen if there were no decomposers?
   a. dead animals and plant parts would still decompose.
   b. nutrients would not get back into the soil, water, and air.
   (c.) both a and b

Answer Key and Sample Answers

Name: _____

Read each question and write a complete answer. (2 points each)

6. What are three ways that decomposers help forests and other ecosystems?
They are food for other things in food chains. They help break down matter and keep dead things from covering Earth. They release nutrients inside dead things back into the ecosystem.

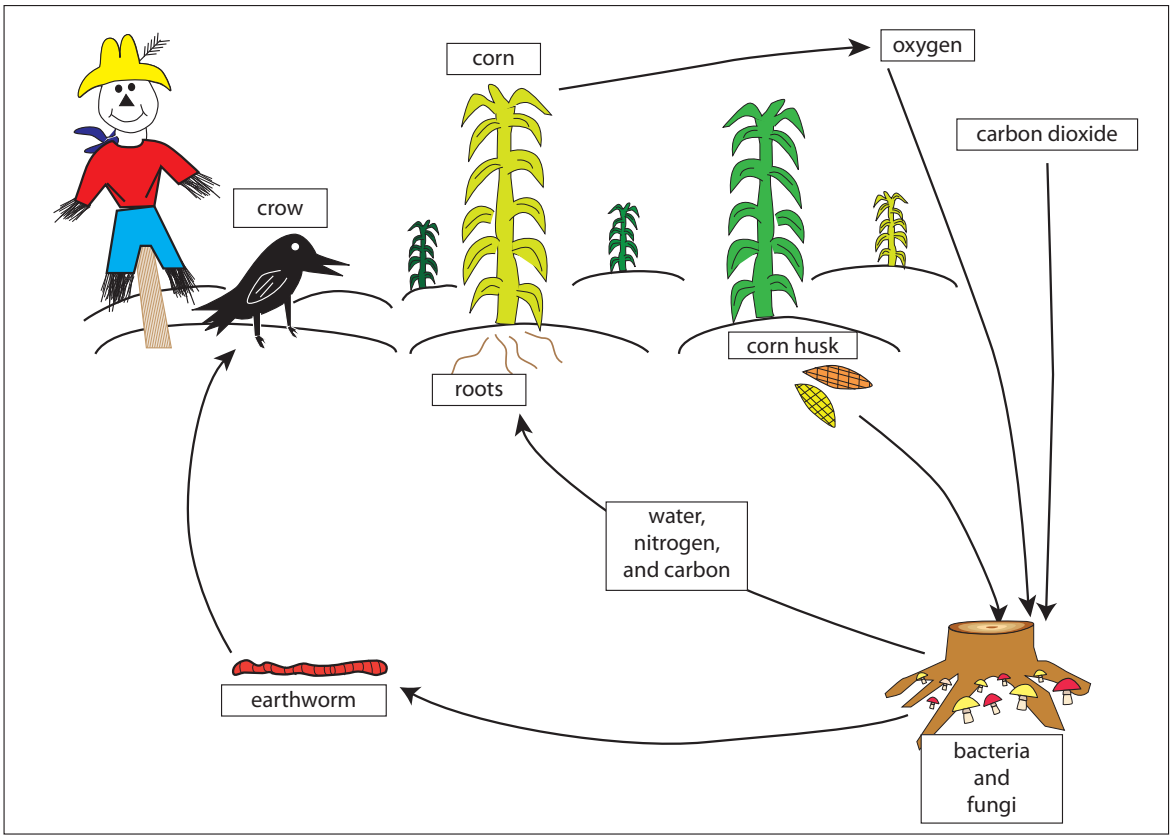
7. Why does agriculture need decomposers?
Decomposers make the topsoil better for growing crops by releasing nutrients from dead things into the soil. Decomposers make humus, which helps soil hold in water for plants to use.

8. How does our wastewater management system use decomposers?
Decomposers break down the waste that comes out of our houses. They break it down more at the treatment plant and in the rivers, lakes, and ocean where the wastewater goes.

9. How do our communities use decomposers to manage our garbage?
Humans put things like apple cores in a compost bin. Decomposers break down this garbage and turn it into compost. If garbage is composted, then there is less garbage going into the landfill.

Name: _____

Look at the diagram and then answer the questions. (2 points each)



10. Name two decomposers in the diagram.
Bacteria and fungi

11. How are these decomposers connected to other things in this diagram?
The decomposers are food for the worm. They break down the dead corn husk and release nutrients back into the air and soil for plants to use.

12. How do humans depend on what is happening in this diagram?
Growing food depends on decomposers to create humus and release nutrients. The plants could not grow without those. Without decomposers, the food chains would stop, too.

Alternative Unit Assessment

Description

This alternative unit assessment can be used in conjunction with, or in place of, the traditional assessment. In this task, each student creates a poster that shows decomposers and decomposition in an ecosystem of the student's choice. On the poster, students must name the decomposers, describe their role in food chains and the nutrient cycle, and describe why they are essential to natural systems and human practices.

Advanced Preparation

Gather and prepare Materials Needed.
Gather and prepare Alternative Unit Assessment Masters.
Gather and prepare Visual Aids:

- Gather from previous lessons:
  - **Large Decomposition Diagram** from Lesson 3. Make sure it is hanging in a visible place.

Materials Needed

- Colored pencils and markers
- Poster paper (white): one per student (four-foot pieces of white butcher paper may be substituted)
- Rulers

Alternative Unit Assessment Masters:

- **Decomposition Poster Instructions**
  One per student

Suggested Scoring

The rubric on page 27 describes elements that should be included in the students' posters as well as expectations for student performance. The highest possible score is 16 points on the rubric.

Preparation Time

30 min.

Assessment Time

50 min. of in-class time, plus homework time to be determined by teacher

Safety Notes

None

Procedures

Step 1

Remind students that they have seen and have made several diagrams that show decomposition in ecosystems. Point out the **Decomposition Diagram** (see Advanced Preparation) to students as one example.

Tell students that they are going to create a decomposition diagram of their own, showing how decomposition is important to all ecosystems.

Step 2

Distribute the **Decomposition Poster Instructions** (Alternative Unit Assessment Master). Read the directions aloud with students and clarify the task by answering any questions they have. Point out the rubric to students so that they know how their posters will be scored. Instruct students to add the due date in the space at the bottom of the instructions page.

Step 3

Give students the rest of the class period to gather materials and information on the ecosystem of their choice or to begin their posters using the materials available.

Step 4

Tell students how much out-of-class time they have to complete the assignment. On the board, write the due date for students' posters to be complete.

Scoring Tool for Alternative Assessment

Decomposition Poster Rubric

Element	4 points	3 points	2 points	1 point
Parts of the Ecosystem	The diagram shows five or more organisms and parts of their habitats.	The diagram shows three or more organisms and parts of their habitats.	The diagram shows one or two organisms and parts of their habitats.	The diagram shows only the organisms. It does not include the non-living parts of their habitats.
Decomposers in the Food Chain	All organisms drawn are named and identified with labels that indicate their place in the food chain.	Many organisms are named and identified with labels that indicate their place in the food chain.	Most organisms are named and identified with labels that indicate their place in the food chain.	Fewer than half of the organisms are named and identified with labels that indicate their place in the food chain.
Decomposers in the Nutrient Cycle	Arrows are drawn and labeled showing where nutrients are released by all decomposers back into the ecosystem.	Many arrows are drawn and labeled showing where nutrients are released by decomposers back into the ecosystem.	Some arrows are drawn and labeled showing where nutrients are released by decomposers back into the ecosystem.	No arrows are drawn or labeled showing where nutrients are released by decomposers back into the ecosystem.
Human Practices That Rely on Decomposers	Poster identifies and describes more than two ways humans depend on the decomposers in the ecosystem.	Poster identifies and describes two ways humans depend on the decomposers in the ecosystem.	Poster identifies one way humans depend on the decomposers in the ecosystem.	Poster does not identify any ways humans depend on the decomposers in the ecosystem.

Decomposition Poster Instructions

Alternative Unit Assessment Master

Make a poster that shows the roles of decomposers and decomposition. First, choose an ecosystem. Then think about how you will show the following:

- **The decomposers in the ecosystem.** What do they look like? How big are they? Where are they found? What do they do?
- **How decomposers are part of the food chain.** What do decomposers eat? Who eats them?
- **What the ecosystem gets from decomposers.** What happens when decomposers do their jobs really well? What does the ecosystem get?
- **Why the decomposers are important to humans.** What do humans depend on from this ecosystem? How do the decomposers help?

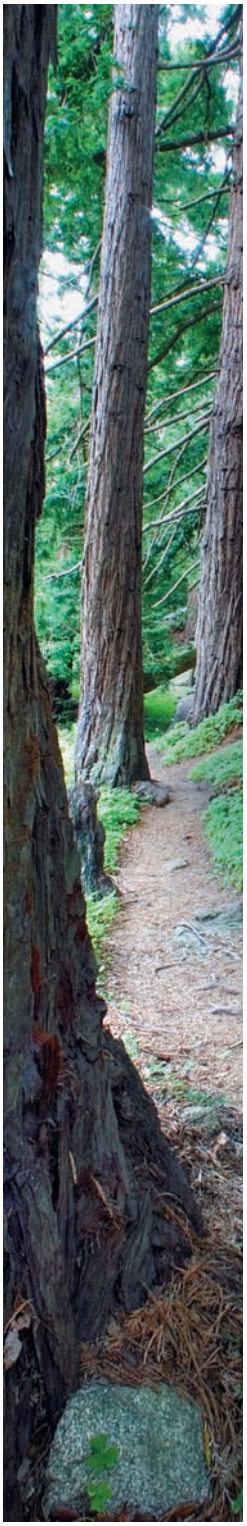
Make sure you put your **name** and a **title** on your poster.

Here is how your poster will be scored:

Your Poster Shows	4 points	3 points	2 points	1 point
Parts of the Ecosystem	The diagram shows five or more organisms and parts of their habitats.	The diagram shows three or more organisms and parts of their habitats.	The diagram shows one or two organisms and parts of their habitats.	The diagram shows only the organisms. It does not include the non-living parts of their habitats.
Decomposers in the Food Chain	All organisms drawn are named and identified with labels that indicate their place in the food chain.	Many organisms are named and identified with labels that indicate their place in the food chain.	Most organisms are named and identified with labels that indicate their place in the food chain.	Fewer than half of the organisms are named and identified with labels that indicate their place in the food chain.
Decomposers in the Nutrient Cycle	Arrows are drawn and labeled showing where nutrients are released by all decomposers back into the ecosystem.	Many arrows are drawn and labeled showing where nutrients are released by decomposers back into the ecosystem.	Some arrows are drawn and labeled showing where nutrients are released by decomposers back into the ecosystem.	No arrows are drawn or labeled showing where nutrients are released by decomposers back into the ecosystem.
Human Practices That Rely on Decomposers	Poster identifies and describes more than two ways humans depend on the decomposers in the ecosystem.	Poster identifies and describes two ways humans depend on the decomposers in the ecosystem.	Poster identifies one way humans depend on the decomposers in the ecosystem.	Poster does not identify any ways humans depend on the decomposers in the ecosystem.

My Decomposition Poster is due on: _____ .

Extensions & Unit Resources



Extensions

Conduct additional decomposition demonstrations, placing organic and inorganic items in separate containers of soil. Add air holes and measured amounts of water to some containers and have students track how long it takes each item to decompose.

Start a worm bin in the classroom (vermicomposting). Have students feed the worms and track decomposition. After three months, have students harvest the compost and use it to pot a plant. Ask students to compare the growth and health of the plant potted in compost versus a plant potted without compost.

Arrange for a field trip to a local community garden that uses composting or to a municipal compost facility. Invite a guest speaker involved in waste management or agriculture to discuss how their work relies on decomposers. Enlist students to help start a compost program at your school.

Arrange for a field trip to a local landfill. When you return to the classroom, have students list the items that they saw that could have been composted, re-used, or recycled.

Resources for Students

Anderson, Margaret. 1991. *Food Chains: The Unending Cycle.* Berkeley Heights, NJ: Enslow Publishers, Inc.

Discovery Education. The Dirt on Soil.
http://school.discoveryeducation.com/schooladventures/soil/field_guide.html

Emory, Jerry. 1996. *Dirty, Rotten, Dead?* Orlando, FL: Harcourt Brace & Company.

United States Environmental Protection Agency. Exploring Estuaries.
http://www.epa.gov/nep/kids

References for Teachers

Brown, Lauren. 1985. *The Audubon Society Nature Guides: Grasslands.* New York: Alfred A. Knopf, Inc.

The Editors of Salem Press, ed. 2004. *Ecology Basics.* Pasadena, CA: Salem Press, Inc.

Environmental Literacy Council. Soil Microbiology. **http://www.enviroliteracy.org/article.php/710.html**

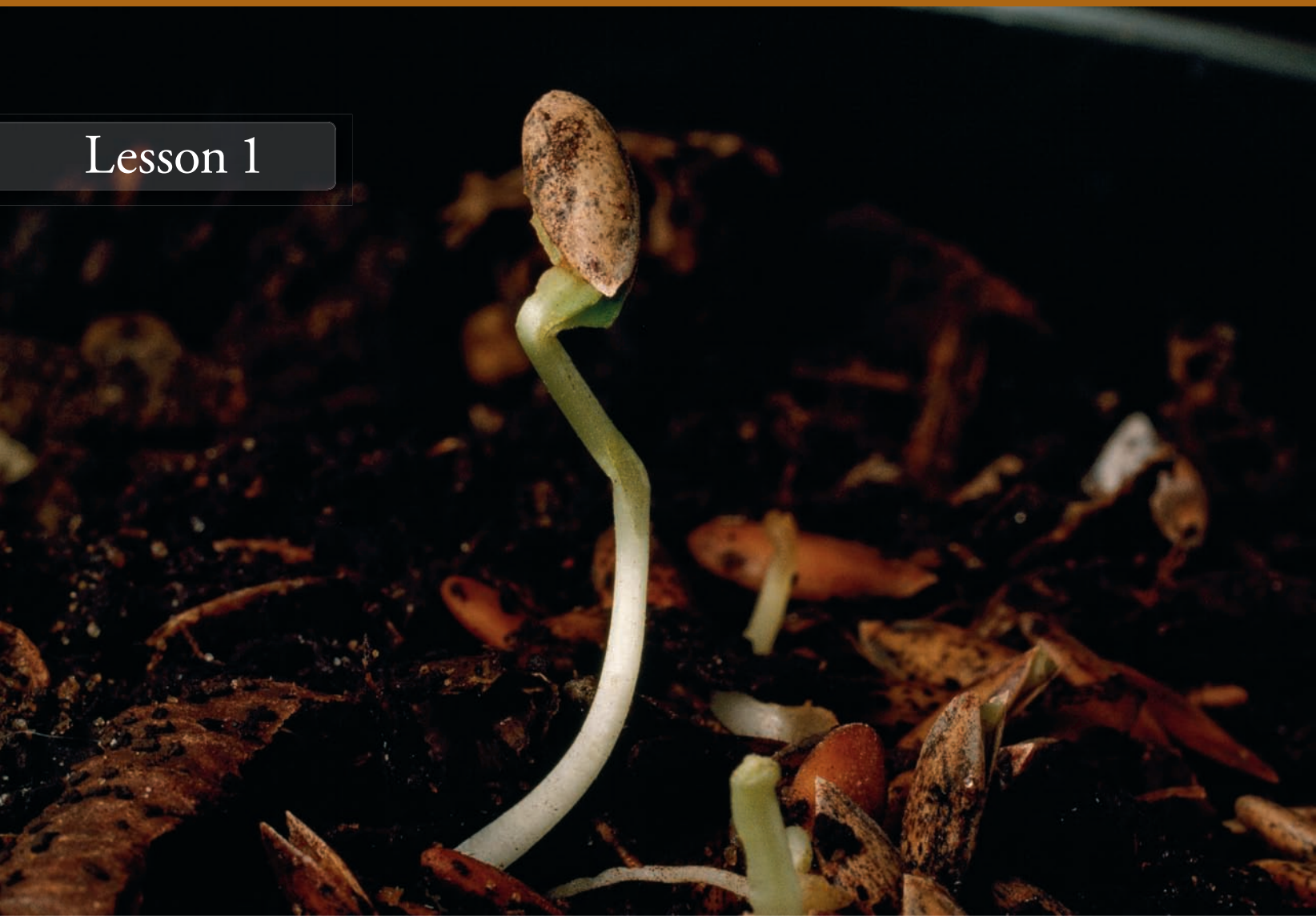
Martin, Deborah L., and Grace Gershuny, ed. 1992. *The Rodale Book of Composting.* Emmaus, PA: Rodale Press, Inc.

Natural Resources Conservation Service. Soil Biology. United States Department of Agriculture. **http://soils.usda.gov/sqi/concepts/soil_biology/biology.html**

Instructional Support

Agencies, institutions, and organizations throughout California have identified themselves as providing programs and materials that support this unit. Links to these resources are available at **http://www.calepa.ca.gov/Education/EEI/instructional_support.html.**

Lesson 1



Cantaloupe sprouting in compost

Breaking It Down

When studying food chains and food webs, students typically place decomposers in the last trophic level, where they feed on dead animals or plant parts. This lesson challenges that perspective, helping students understand the true significance of decomposers.

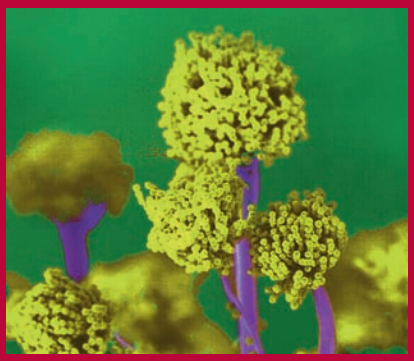
Beginning with this first lesson, students learn how decomposers fit into multiple trophic levels, break down matter, and help cycle nutrients in all ecosystems.

This lesson introduces students to the microscopic, yet dynamic, world of decomposers. Students read about food chains found in various types of compost systems in ***California Connections: Wonderful Compost*** and identify the producers and consumers mentioned in the reading. Through discussion, students identify decomposers in the story and their role in the food chain, learn the term "decomposition," and recognize that decomposers interact with the "living" as well as the "dead." This lesson prepares students to explore the processes by which decomposers help cycle nutrients in ecosystems and support human practices such as food production (agriculture) and waste management.

Learning Objective

Give examples of organisms that are decomposers.

Provide examples of human practices that directly depend on the cycles and processes involving decomposers in terrestrial, freshwater, coastal, and marine ecosystems (e.g., their role in food production and waste management).



Background

In food chains and food webs, decomposers often appear to be an afterthought. Since the food chain highlights energy transfer, producers become the stars; that is, they garner the most attention because they are capable of converting the sun's energy to matter. Naturally, consumers come next, eating producers and other consumers and then, usually, passing on their energy and matter by being eaten themselves. If depicted at all, decomposers are isolated in food chains. They are the organisms at "the end of the line" that "eat the dead stuff." The word "decomposer" brings to mind unattractive molds that ruin our breads and fruits, or bacteria that we cannot even see but that cause infection and illness.

A decomposer's relationship to the rest of the components in an ecosystem is complex. In addition to being consumers themselves, feeding on organic matter, decomposers are food for other consumers and aid most consumers in their digestive processes. Furthermore, decomposers break down organic matter into its simplest chemical components, making it useful and accessible to plants and animals.

Humans build compost bins or piles as a means of creating a maintained habitat for decomposers and encouraging the decomposition process. In compost bins, fruit and vegetable scraps play the role of the producers, providing energy and matter for food chains. Invertebrates such as earthworms and pill bugs act as consumers, eating decomposers in the process of scavenging on dead plant matter. Meanwhile, decomposers such as bacteria and fungi feed on the bins' plant matter and the wastes of the earthworms and pill bugs. As decomposers obtain energy and matter from the fruit and vegetable scraps and consumer wastes, they break them down into their simplest components, such as carbon, nitrogen, hydrogen, and oxygen. In this sense, a compost bin provides a close-up view of some of the natural system interactions that occur within terrestrial, aquatic, and marine ecosystems.

Compost bin

Key Vocabulary

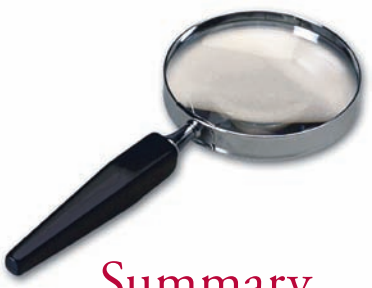
Bacteria: Microscopic, one-celled organisms that play a key role in decomposition.

Decomposers: Bacteria, fungi, and mold that obtain energy and matter by breaking down the remains of dead organisms into their chemical and mineral components.

Decomposition: The breaking down of dead organisms into their chemical and mineral components.

Matter: What all things are made of.

Toolbox



Summary of Activities

Students read a story about three approaches to composting, identify the decomposers in the described compost bins, and diagram the food chains represented. They set up a composting lab using bananas and yeast, and make predictions about the decomposition process.

Instructional Support

See Extensions & Unit Resources, page 30.

Prerequisite Knowledge

Students should know:

- what plants need to survive.
- the basic components of soil.

Students should be able to:

- define the term "food chain."
- identify producers and consumers within food chains.
- generate a reasonable prediction based on prior knowledge or experience.
- use a gram scale to determine the weight of an object.

Advanced Preparation

Gather and prepare Activity Masters.

Gather and prepare Materials Needed:

- Cut bananas into one-inch slices.

Word Wall Cards:

- Choose an area on the wall to place the Word Wall Cards for the unit.

Make Storage Space:

- Create a space (preferably in a cabinet) for storing pairs of sealed plastic bags with composting samples.

Prepare Composting Lab Materials:

- Prepare a set of the following materials for each group of four students: two slices of banana on a paper towel, two plastic bags that can be sealed, a teaspoon, and a marker. You may want to place the materials for each group on a plastic tray for easy management.
- Empty the yeast from the packets into the extra plastic bag for easy access during the lesson.

Materials Needed

My Decomposition Book:
- Provided separately

Activity supplies:
- Bananas: four per class, ripe
- Dry active yeast: four packets per class
- Knife: one per class
- Paper towels: one per group of four
- Self-sealing plastic bags: two per group of four students, plus one extra for the teacher
- Teaspoons: one per group of four
- Trays: one per group of four

Class supplies:
- Chart paper (optional), markers, masking tape, stapler, staples

Unit Dictionary:
- Provided separately

Visual Aids

No visual aids are required for this lesson.

Duration

Preparation Time
45 min.
Instructional Time
50 min.

Safety Notes

Students should not eat or inhale yeast, or handle the knife.

Activity Masters in the Supporting Materials (SM)

California Connections: Wonderful Compost
SM, Pages 7–11
One per student

Procedures

Vocabulary Development

Use the **Unit Dictionary** and the **Vocabulary Word Wall Cards** to introduce new words to students as appropriate. These documents are provided separately. Ask students to write their name in the space provided in the Unit Dictionary.

Step 1

Ask students to explain what a food chain is and to give examples of food chains. (*A food chain shows how energy in food moves from one living thing to another. It also shows where living things get their energy [what they eat]. One example might be a plant with a seed, which a mouse eats; an owl then eats the mouse.*) Draw or write one of the food chains students describe on the board.

Ask students to identify the producers and consumers in the food chain on the board. (*Answers will vary; students should name the plants [or plant parts] as producers and the animals and people as consumers.*)

Step 2

Ask students, "Where do producers get their energy?" (*From the sun*) "Is the sun all that plants need to grow?" (*No, they also need water and nutrients from the soil.*) "Where does the soil get the nutrients it contains?" (*Answers may vary. Students may know that the nutrients in soil come from dead plants and animals.*) Tell students that the soil gets the nutrients it contains from plants and animals through an important process called "decomposition."

Step 3

Distribute and have students read ***California Connections: Wonderful Compost*** (Lesson 1 Activity Master). After students have finished reading the story, refer to the term and definition of "decomposer" written on the board or on chart paper (see Advanced Preparation) and ask students to identify the decomposers in the story. *(Mites, pill bugs, snails, springtails, beetles, ants, flies, earthworms, and bacteria*)

Help students to see how the decomposers in the story fit into the food chain by asking the following questions:

- What organisms ate the decomposers? *(The worms ate the decomposers.)*
- On what things did the decomposers feed? *(The decomposers fed on the fruit and vegetables and the wastes of the worms.)*
- What happened to the things on which the decomposers fed? *(The decomposers broke down the things they fed on into their simplest parts.)*

Step 4

Have a student volunteer come up to the board and diagram the food chain in the story that included the earthworm and bacteria. (*apple core > bacteria > earthworm > bacteria*) Ask students what they think would happen to the food chain if the decomposers were not there. (*The fruit and vegetables would not get broken down. The dead earthworm would not get broken down. The wastes of the worms would not get broken down. The worms would not have bacteria to eat.*)

Tell students that compost bins are not part of nature, and ask them where decomposition might happen in nature. (*In a garden, on a forest floor*) Ask students to give examples of what worms and bacteria help to break down besides fruit scraps like apple cores. (*Answers will vary, but should include leaves, tree trunks, flowers, fruit, and dead animals.*)

Step 5

Organize the class into groups of four. Distribute a copy of ***My Decomposition Book*** to each student. Have them put their names on the cover and turn to page 1. Point out the "Decomposition Vocabulary" heading at the top of the page. Instruct students to read the Key Vocabulary words on the board, find those words on their "Decomposition Vocabulary" pages, and write the definitions from the board in their copies of ***My Decomposition Book***.

Distribute the composting lab materials (see Advanced Preparation) while students are working on their vocabulary.

Step 6

Tell students that they are going to work in groups to prepare a composting demonstration of their own. Instruct one student in each group to write their initials and the date on both plastic bags and the word "yeast" on one and the words "no yeast" on the other. (Write the word "yeast" on the board to help students with spelling.)

Instruct another student in each group to place a slice of banana in each of the bags.

Circulate around the room with the bag of yeast to give each student a look at it. Tell the class that yeast is a decomposer—a living thing that breaks down the sugar in other living things.

When you get to each group, have a third student from the group use the teaspoon to take half a spoonful of yeast from the bag and sprinkle it onto the banana slice in the bag that is labeled with the word "yeast." Check to make sure that the other bag in each group is marked "no yeast" and contains a slice of banana.

Tell the fourth student in each group to carefully seal both bags.

Step 7

Tell the groups to open their copies of ***My Decomposition Book*** to page 3, titled **"Banana Composting Lab Sheet."** Ask students to write their predictions as to what they think will happen to the bananas in each of the bags. Invite students to share their predictions with the class. Give students time to answer the questions at the bottom of the page.

Have the student who marked the bags for each group carefully bring both bags to the area where their "compost" will be stored, and have the rest of the group make sure that the remaining materials are back on the plastic trays or in the center of the workspace.

Step 8

Collect students' copies of the ***My Decomposition Book*** when they have completed their answers to the questions (they may need homework time for this) to use in assessment.

Lesson Assessment

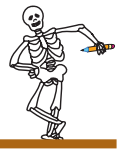
Description

This lesson introduces students to some examples of decomposers and the role of decomposition in breaking down dead matter into its chemical components. Students' answers to the questions on the **Banana Composting Lab Sheet** on pages 3 and 4 of ***My Decomposition Book*** demonstrate their ability to give examples of decomposers and explain how natural systems and humans depend on them.

Suggested Scoring

Use the Answer Key and Sample Answers provided on page 39-40 to assess student work.

Answer Key and Sample Answers



Banana Composting Lab Sheet

Section 1: Predictions

What do you think will happen to the banana slice in the bag with yeast?

I predict that *Based on the information available, students will probably predict that the banana will decompose.*

What do you think will happen to the banana slice in the bag without yeast?

I predict that *Students may predict that the banana will or will not decompose.*

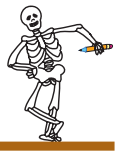
Section 2: Observations

Use this space to draw what the banana slices look like.

A. Beginning Date: *The date should be the day on which the demonstration took place.*

Bag with Yeast	Bag without Yeast
Student drawings should show the bag, the slice of banana, and the presence of yeast.	*Student drawings should show the bag and the slice of banana.*

3



Banana Composting Lab Sheet

Draw what you see in each bag:

B. Ending Date: _____

Bag with Yeast	Bag with No Yeast
Student drawings should show the bag, the slice of banana, and the change in the banana after the experiment.	*Student drawings should show the bag, the slice of banana, and the change in the banana after the experiment.*

Section 3: Questions

What decomposers did you learn about in this lesson?

I learned about worms, bacteria, and yeast.

How are decomposers helpful?

Decomposers are helpful to other plants and animals because they break down things we throw away to make compost. They help put nutrients in the soil. The nutrients help grow food and other plants that keep food chains going.

4

Wonderful Compost

The warm days of summer turn cooler. Tree leaves shake and rustle in the wind. It is October, and crisp red apples ripen on the trees. In the fall, Juliana Kelly loves to pick apples. Her family goes to an apple orchard every year.

The orchard is in the foothills of the Sierra Nevada Mountains. Its name is Apple Hill. Juliana picks sweet, red apples and puts them in her basket. She will eat the apples in pies, as a snack, and in her school lunch.

At home, Juliana helps her mother make apple pies for the neighbors. She carefully takes the core out of each apple. All of these apple cores have to go somewhere. Juliana has some choices. She can put the apple cores in the trash. A garbage truck will pick up the trash and take it to a landfill. Juliana has another choice. She can save the apple cores for the family compost pile.

Apple tree

Apple core

Juliana decides not to put the apple cores in the garbage. Instead, she adds them to the compost pile in her backyard. She throws the apple cores on top of the compost pile with other vegetable, fruit, and food scraps. Then she adds some grass from the lawnmower bag. She sprinkles some rich, black soil on top.

The apple cores and the cut grass soon begin to rot. Scientists use the word "decompose" to explain what happens to the food scraps. Tiny organisms live in the pile. Bacteria and fungi change the chemistry of the food, and break it down into nutrients that enrich the soil. Chemical decomposers are tiny. People need a microscope to see them.

Mites, pill bugs, snails, and springtails live in Juliana's yard. So do beetles, ants, flies, and earthworms. They all find their way to the compost pile. These physical decomposers or scavengers grind, bite, chew, and tear the food into tiny pieces. They work with bacteria and fungi. Together they turn the food scraps into compost.

Juliana knows that the decomposers need help. They must have water, air, and lots of food to make healthy compost. Juliana sprays her compost pile with water every few days. She uses a shovel to turn the compost pile. Turning the pile gives the decomposers a fresh supply of air. She also makes sure they have lots of fresh food scraps.

The compost is ready to use in a few months. It smells and looks like rich, healthy soil. Juliana puts the new compost in her garden. She mixes it with the soil. Then she plants pumpkin seeds and tomato seeds. She waters them well. Soon she will see tiny plants begin to sprout. Juliana will watch her pumpkins and tomatoes grow. Her family will begin to eat them when summer comes. Juliana will remember her

Apples in compost pile

compost each time she bites into a juicy tomato.

Juliana's mother takes a fresh apple to work. After she eats her snack, she puts the apple core in a covered box. In the box are hundreds of wriggling red worms. Tiny decomposers also live in Mrs. Kelly's box.

The red worms begin to eat the apple core. Their intestines are rich with juices. These juices break down the food. The worms leave behind droppings. The name for their droppings is "castings." Tiny decomposers will break down the castings and release vitamins a minerals. These n are good for plant Kelly will use the c

Red worms feeding

to help her garden grow.

When a worm dies in the worm box, tiny bacteria go to work. They break down the carbon, nitrogen, and protein in the worm's body. Bacteria need carbon and nitrogen for energy. They need protein to grow and multiply. Decomposers like bacteria leave their own waste behind. This waste is rich in nitrogen, phosphorus, and magnesium.

Green waste collection

decompose food waste. Vermicomposting is a good choice for people who want to compost but do not have a big backyard. A box of special red worms takes little space. People can buy the worms online or at a local nursery. The worms need bedding like shredded newspaper. They need a steady supply of food scraps. They need someone to make sure their home doesn't get too wet or too dry.

Many classrooms have worm bins. Sometimes students put the castings in their school gardens. Other students take the castings home for their houseplants.

Lucas Garcia is a young boy who lives in Alameda, a town near San Francisco. He does not have a garden. But he knows how to use his family's food scraps for compost. Lucas reminds his family to put their food waste in a special bucket by the sink. When it is full, he dumps it into a green waste cart outside the house. Mrs. Garcia puts grass into the green waste cart after she mows the lawn.

Each week Lucas pushes the green cart to the street. A special green truck picks up the Garcias' green waste. The truck stops at every house in Alameda. The green waste goes to one big composting place. There, decomposers and scavengers turn the waste into compost. Other cities send their green waste to the same place. California has so much green waste that it creates 4 million tons of compost each year.

Farms, vineyards, and orchards use the compost that Lucas helps the city make. Farmers in the Central Valley, Napa Valley, and Sonoma Valley add compost to their soil. They add compost to orange, avocado, and almond

Tractor turning compost pile

trees. Compost also helps grapes, tomatoes, and other crops. Farmers who use compost can water less. They can also cut back on use of chemical fertilizers, which can sometimes pollute the environment and make animals sick. Compost makes the soil and plants healthier. Using compost is good for farmers. It is also good for our land, food, and water.

Making compost means putting less in the garbage can. Less trash means fewer garbage trucks. This means less traffic and pollution. Less traffic and pollution can mean better air to breathe. Landfills will fill more slowly if people make less trash. Many landfills are built on open space that provides habitat for wild animals. When new landfills are built, habitat for animals is often destroyed. Finding new places to take our garbage is very difficult. Every person in California makes about 58 pounds of trash each month. You probably already recycle bottles, cans, and paper. How much less trash would you make if you made compost?

Juliana and Lucas feel good about composting their food waste. They use what some would call garbage to make soil healthier. They know that making compost with the help of decomposers is an important step. Their families and their friends can enjoy healthy food and safe water. Food grown in composted soil can improve the quality of life for all.

Lesson 2

Red velvet mites

Decomposers and Scavengers

Decomposers possess unique abilities to break down matter chemically and convert it into its simplest components: carbon, nitrogen, hydrogen, and oxygen. Other organisms, called scavengers, help with this "break down"; scavengers do not, however, break down material into its simplest components.

Instead, through their feeding process and physical digestion, they break down material into smaller pieces for "true" decomposers to work on. In the end, decomposers complete the process. In order for students to be able to identify "true" decomposers, they must understand this difference.

In Lesson 2, students describe different decomposers and learn to distinguish "true" decomposers from scavengers. Students define the term "scavenger," review the definition of a decomposer, and compare the two definitions. They look at a series of photographs featuring "true" decomposers and scavengers and use clues in the captions to categorize each organism as a decomposer or a scavenger. The ability to distinguish true decomposers from scavengers helps students build on their knowledge about the role of decomposers in ecosystems.

Learning Objective

Give examples of organisms that are decomposers.

Explain the role of decomposers in an ecosystem.

Background

Decomposers are organisms that feed on dead plants, animals, and other organic matter. These organisms carry out the natural process of decomposition. Decomposers obtain the energy and matter they need for growth from dead organic matter. Bacteria and fungi are decomposers.

Sometimes people refer to organisms like earthworms, pill bugs, and mites as decomposers because they also consume dead organic matter. Other scavengers known for eating carrion (animal carcasses) are typically larger animals; these scavengers include coyotes and vultures like the California condor. Although their biting, chewing, and swallowing do assist with decomposition, these organisms on their own are not capable of chemically breaking down matter into its elemental components. For this reason, they are scavengers rather than "true" decomposers. "True" decomposers are capable of digesting many complex chemical molecules and reducing them to carbon and inorganic components such as nitrogen.

For example, consider leaves that fall to the forest floor. Over time, they become weathered. The smaller bits of leaf litter mix with the soil; scavengers like the earthworm eventually eat these smaller bits. The earthworm's gizzard grinds the leaf litter into even smaller pieces, which pass into its intestine. Inside the earthworm's intestine, bacteria feed on the tiny pieces of leaves and begin to break them down chemically. The earthworm is not capable of this chemical digestion on its own. Instead, the earthworm excretes nutrient-rich waste known as "castings," and bacteria feed on the castings and continue to break them down chemically. As the bacteria complete the decomposition process, they release carbon, nitrogen, hydrogen, and oxygen trapped within the leaf litter back into the natural system. These elements are then available for another use. If bacteria were not capable of chemical digestion, then earthworms and other scavengers could only breakdown organic matter to a certain point, and nutrient cycles that support natural systems could not continue.

Leaf eaten by scavengers

Key Vocabulary

Fungus: An organism such as a mushroom that obtains energy and matter primarily from dead organic matter.

Microorganism: An organism such as a bacterium or fungus that is seen only with the aid of a microscope.

Scavenger: An organism that obtains energy and matter by eating dead organisms.

Toolbox

Summary of Activities

Students match descriptions of decomposers and scavengers to the pictures and names of actual organisms. They compare characteristics of decomposers to those of scavengers. Using clues, students identify examples of decomposers and scavengers on photo cards.

Instructional Support

See Extensions & Unit Resources, page 30.

Prerequisite Knowledge

Students should have:

- completed the previous lesson.

Advanced Preparation

Gather and prepare Activity Masters.

Gather and prepare Materials Needed:

- **My Decomposition Book**

Gather and prepare Visual Aids:

- Cut apart the **Decomposers and Scavengers Photo Cards** (Visual Aid #1–4).

Add to Word Wall.

Materials Needed

Class supplies:

- Pencils, scissors, tape

Visual Aids

Photo cards:

- **Decomposers and Scavengers,** Visual Aids # 1–4

Duration

Preparation Time
20 min.

Instructional Time
50 min.

Safety Notes

None

Activity Masters in the Supporting Materials (SM)

No Activity Masters are required for this lesson.

Procedures

Vocabulary Development

Use the **Unit Dictionary** and the **Vocabulary Word Wall Cards** to introduce new words to students as appropriate. These documents are provided separately.

Step 1

Distribute students' copies of **My Decomposition Book**. Instruct students to read over the definitions of vocabulary words they have already filled in on page 1. While students are reading, place the **Decomposers and Scavengers Photo Cards** (Visual Aids #1–4) face up on various tables around the room, one card per table.

When you have placed the **Decomposers and Scavengers Photo Cards** around the room, have students turn to page 5 in their copies of **My Decomposition Book**. Read through the instructions for completing the page.

Step 2

Assign four students to each of the tables on which you placed one of the photo cards of **Decomposers and Scavengers**. Ask students to look at each photo card, read the caption, and take note of the number written in the left-hand corner of the card. Tell students to write the name of the organism in the correct box on page 5 of ***My Decomposition Book***. Remind them that the name next to the number on page 5 should match the number they see on the photo card at their table.

When the groups have finished examining their first photo, have them rotate from table to table every three minutes until every student has had a chance to see every photo. When they have all completed the task, have the students return to their regular seats. Collect the photo cards from the tables.

Step 3

Review with students the Key Vocabulary and definitions for "decomposer" and "scavenger" on the word list (see Advanced Preparation). Remind students what they learned from the ***Wonderful Compost*** story about chemical decomposers and physical decomposers, or scavengers. Ask students, "What is the main difference between decomposers and scavengers?" (*Only decomposers can break down dead plants and animals into their simplest parts. Scavengers can grind, bite, or tear the matter into smaller pieces, but they cannot break it down chemically.)*

Have students locate the new Key Vocabulary terms on pages 1 and 2 in their copies of ***My Decomposition Book*** and fill in the definition for each.

Step 4

Ask students, "Which organisms on the photo cards are scavengers?" *(California condor, earthworm, millipede, pill bug, blowfly)* As students name these, hold up these photo cards for the class to see, and then tape them to one side of the board. Ask students, "Which organisms on the photo cards are decomposers?" (*Bacteria, mold, mushroom, blowfly)* As students name these, hold up these photo cards for the class to see, then tape them to the other side of the board.

Write "Scavengers" above the group of photo cards showing scavengers and "Decomposers" above the group of photo cards showing the decomposers.

Point to the photo of the blowfly once again. Tell students that the blowfly belongs in both categories. It uses its mouth parts to bite and suck up food, but also uses chemicals to soften the food it bites into its basic chemical components.

Step 5

Instruct students to write a letter "D" next to the organism names on page 5 of ***My Decomposition Book*** that are decomposers and "S" next to the organisms that are scavengers. Read each of the names of the organisms aloud as students do this. *(Number 1 is bacteria [D], number 2 is a California condor [S], number 3 is an earthworm [S], number 4 is mold–a type of fungus [D], number 5 is a mushroom–also a type of fungus [D], number 6 is a millipede [S], number 7 is a blowfly [both S and D], and number 8 is a pill bug [S].)*

Step 6

Instruct students to answer the questions below the list of organisms on page 5 of ***My Decomposition Book***. When students are finished, collect their copies of ***My Decomposition Book*** to use in assessment.

Lesson Assessment

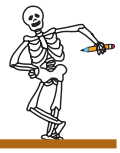
Description

This lesson teaches students about the role decomposers play in ecosystems. Key to the lesson is helping students distinguish between scavengers and "true" decomposers. It also provides students with additional examples of decomposers. Students' work on page 5 of **My Decomposition Book** demonstrates that they can give examples of decomposers and explain their role in an ecosystem.

Suggested Scoring

Use the Answer Key provided on page 51 to assess students' work.

Answer Key and Sample Answers



Decomposer or Scavenger?

Decomposition takes a team effort! Making it happen requires two kinds of organisms. You are about to see photos of both kinds of organisms.

Write the name of each organism you see next to the number of its photo:

1. *bacteria (D)*	5. *mushroom (D)*
2. *California condor (S)*	6. *millipede (S)*
3. *earthworm (S)*	7. *blowfly (S and D)*
4. *mold (D)*	8. *pill bug (S)*

How are scavengers and decomposers different?

Scavengers bite and chew to break down what they eat. Decomposers use chemicals to break down what they eat.

How do decomposers and scavengers work together?

Scavengers break things into smaller pieces that are easier for the decomposers to work on.

What do scavengers and decomposers get from eating dead things?

They get their food and energy from eating dead things.

5

1 **Decomposers and Scavengers Photo Cards**
Visual Aid — Photo Cards Front

1 **Decomposers and Scavengers Photo Cards**
Visual Aid — Photo Cards Back

1. We are microscopic, one-celled organisms. You can't see us, but we are everywhere and we can break down almost anything. (**Bacteria)**

2. I am a type of bird. My excellent eyesight helps me to find my food from far away. I eat dead animals. (**California condor)**

2 **Decomposers and Scavengers Photo Cards**
Visual Aid — Photo Cards Front

2 **Decomposers and Scavengers Photo Cards**
Visual Aid — Photo Cards Back

3. My body is long, soft, and made up of segments. I tunnel through the soil and eat bacteria, fungi, and rotting plant parts.
(Earthworm)

4. I am a fungus. I am blue and gray in color. You can often find me on old food like bread and fruit, which I break down. I like damp places.
(Mold)

3 **Decomposers and Scavengers Photo Cards**
Visual Aid — Photo Cards Front

3 **Decomposers and Scavengers Photo Cards**
Visual Aid — Photo Cards Back

5. I am a fungus. I often have a thick stem called a stalk and a cap that looks like an umbrella. I sometimes live on trees and other living things.
(Mushroom)

6. I have a rounded worm-like body, and I have many legs. I can be several inches long and come in a variety of colors. I eat rotting plants.
(Millipede)

4 **Decomposers and Scavengers Photo Cards**
Visual Aid — Photo Cards Front

7. Blowfly

8. Pill bug

4 **Decomposers and Scavengers Photo Cards**
Visual Aid — Photo Cards Back

7. When I am young, I am a maggot. I can smell dead animals from 10 miles away. I use chemicals to soften the food I suck up and eat.
(Blowfly)

8. I have seven pairs of legs. I roll up in a ball when I am bothered. I like to eat leaves that have fallen off plants.
(Pill Bug)

Lesson 3

Leaves on forest floor

A Big Job for a Tiny Crew

Decomposers are the "cleanup crew" in any ecosystem. The digestive processes that decomposers use to "eat" make them important to humans and ecosystems. In their own quest for nutrients, decomposers not only rid the planet of "dead" material, but also make available to living plants and animals the carbon and other essential chemicals and nutrients locked up in dead tissue.

In Lesson 3, students observe evidence of decomposition and discuss steps in the decomposition process. Their observations of the process lead them to discover the important role decomposers play in an ecosystem. Students apply what they know about decomposers and scavengers as they respond to two narratives describing decomposition. Students explain the complexity of the relationship between decomposers and scavengers in food chains by drawing diagrams depicting the characters and sequence of events in the narratives. Students' diagrams of the connections between decomposers and other organisms in an ecosystem demonstrate their understanding of the role decomposers play in the nutrient cycle and the food chain.

Learning Objective

Explain the role of decomposers in an ecosystem.

Recognize that the cycles and processes involving recycling of matter and transfer of energy among organisms are essential to the functioning of natural systems (ecosystems).

Background

Decomposers contribute to ecosystems in multiple ways. They help break down "dead" matter, but they also serve as food for other consumers. Earthworms, springtails, and feather-winged beetles all feed on fungi. A variety of aquatic and terrestrial animals eat bacteria; even humans eat bacteria in cheese and yogurt. Most decomposers reproduce at astounding rates, so they make up a large part of Earth's biomass. Decomposers form the base of many food chains where producers are not available; these food chains exist in the deepest parts of the ocean or in temperatures where plants cannot survive.

Decomposers spend their time feeding primarily on dead organic matter. In doing so, decomposers accomplish two things for the ecosystem. First, they rid the planet of animal wastes, carcasses, and leaf litter by breaking them down through their metabolic processes. If decomposers did not continually feed on dead tissues, waste would overwhelm ecosystems. But there is no waste in nature, because as decomposers feed on dead tissue, they release the nutrients trapped within as byproducts of their own metabolic process. Thus, as decomposers gain the energy they need to live, they release carbon and other nutrients back into the ecosystem.

Evidence of decomposers' continuous efforts is all around us. A rotten apple, moldy bread, a soggy twig, a holey leaf, and a pile of bones are reminders of the work decomposers do in cleaning up and converting wastes into usable nutrients. Decomposers do not act alone, however; rather, they work as a "team" with scavengers. As they eat, scavengers help to break down dead matter into smaller pieces. Decomposers finish the job by chemically breaking those pieces down into their simplest components. This can happen in a number of ways. Some decomposers live inside the intestinal tract of a scavenger and break the matter down there, other decomposers feed on the scavenger's waste after the scavenger excretes it, while others feed directly on dead matter.

Caterpillars eating leaves

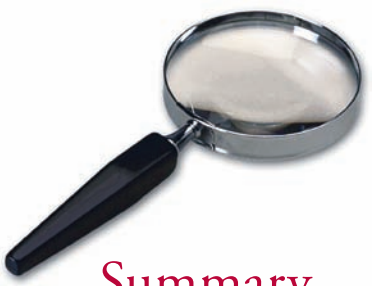
Key Vocabulary

Ecosystem: A specific area, such as a redwood forest, containing a characteristic set of interdependent species that interact with each other and the nonliving components found there.

Nutrient: A substance that provides nourishment for growth and energy to a living thing.

Waste: In a living thing, the matter, such as undigested food, that is not used by the body and is discharged.

Toolbox



Summary of Activities

Students observe evidence of decomposition and apply this concept in a discussion about the role of decomposers in ecosystems. They listen to two narratives describing decomposition and create diagrams showing decomposers and scavengers in the food web.

Instructional Support

See Extensions & Unit Resources, page 30.

Prerequisite Knowledge

Students should be able to:

- Identify characters and events in a story and use a graphic organizer to illustrate the connection between them.

Advanced Preparation

Gather and prepare Activity Masters.

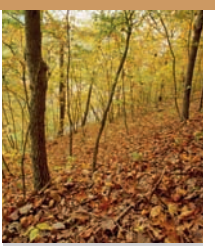
Gather and prepare Materials Needed:

- **My Decomposition Book**

Gather and prepare Visual Aids:

- Prepare transparencies.

Add to Word Wall.



Materials Needed

Activity supplies:

- Butcher paper: One six-foot sheet per class (in a light color)

A-V equipment:

- Overhead or LCD projector, screen

Class supplies:

- Colored pencils, markers, tape

Visual Aids

Transparencies:

- **Evidence of Decomposition**, Visual Aid #5–7
- **Decomposition Diagram**, Visual Aid #8

Duration

Preparation Time
30 min.
Instructional Time
50 min.

Safety Notes

None

Activity Masters in the Supporting Materials (SM)

No Activity Masters are required for this lesson.

Procedures

Vocabulary Development

Use the **Unit Dictionary** and the **Vocabulary Word Wall Cards** to introduce new words to students as appropriate. These documents are provided separately.

Step 1

Distribute students' copies of ***My Decomposition Book***. Select individual students to read aloud the new Key Vocabulary words added to the word list. Discuss the definitions as a class and have students locate the words on pages 1 and 2 in ***My Decomposition Book*** and copy the definition for each new word.

Step 2

Place one of the images in **Evidence of Decomposition** (Visual Aid #5–7) on the overhead or LCD projector. Ask students, "Which of the Key Vocabulary words you have just learned describes what this picture show?" ("*Nutrient" because that is what is inside this matter; "waste" because this is what other organisms, like humans, might throw away.*)

Ask students to share what they think is happening in the picture. (*Decomposers are feeding on the item. Scavengers may have already eaten part of it.*) Ask students what a picture of this same item would show if taken a month later. (*The photo would show less of the item—less matter—and might show more decomposers.*)

Step 3

Show the rest of the images in **Evidence of Decomposition.** With each image, ask students to describe what they see. (*Matter is being broken down—decomposed. There are decomposers or signs of decomposers and scavengers on the matter.*)

Step 4

Explain to students that, when matter decomposes, it seems to "disappear." This occurs because decomposers break down the matter into its chemical parts. Some of these chemicals are the nutrients other things need to live and grow. When plants or animals die, their tissues contain these nutrients. When decomposers feed on those tissues, the nutrients are released back into the soil, air, and water in the ecosystem. Releasing nutrients back into the ecosystem is one important thing that decomposers do for the planet.

Step 5

Ask students to guess what else scavengers and decomposers do that is important in an ecosystem. (*Answers will vary; students may mention that scavengers and decomposers are food for other animals.*) Explain that there are more scavengers and decomposers in ecosystems then all other living things combined. This is important because other animals eat them to get energy and nutrients. If there were no decomposers and scavengers, many food chains would fall apart.

Step 6

Tell students that they will now read two stories about decomposition in their ***My Decomposition Book***. The stories take place in different ecosystems, the forest and the coast. As they read each story, students will label a diagram that shows what is happening in the story. To label their diagrams successfully, they will have to identify all the "characters" in the story and identify how each one fits into the decomposition process.

Step 7

Have students turn to page 6 in ***My Decomposition Book*** where they will find the story ***Decomposition in the Forest.*** Have them go to page 7, **Breaking It Down—In the Forest,** so that they can see the diagram that they will be labeling after they read the story.

Tell the students to read ***Decomposition in the Forest.*** After they have finished reading, tell them to label the events in the story on the basic drawing on page 7 of the ***My Decomposition Book.***

Project the **Decomposition Diagram** (Visual Aid #8) on the overhead or LCD projector. Point out the different "characters" and events in the story that show how decomposers and scavengers fit into the forest food web. Ask students how the nutrients in the story get into the soil and air. (*As they break down matter, decomposers released the nutrients.*) Allow students to adjust the diagrams they made on page 7 in ***My Decomposition Book***, using the information from the transparency.

Step 8

Have students turn to page 8 in ***My Decomposition Book*** where they will find the story ***Decomposition at the Coast.*** Have them go to page 9, **Breaking It Down—At the Coast,** so that they can see the diagram that they will be labeling after they read the story.

Tell the students to read ***Decomposition at the Coast.*** After they have finished reading, tell them to label the events in the story on the basic drawing on page 9 of the ***My Decomposition Book.***

Collect students' copies of ***My Decomposition Book*** to use in assessment.

Lesson Assessment

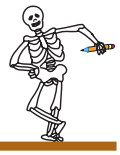
Description

The lesson teaches students that decomposers have several important roles in ecosystems and that, without them, other organisms in ecosystems could not live, eat, or grow. Students demonstrate that they recognize the importance of decomposers and scavengers and can explain their roles in ecosystems by labeling the drawing on page 9 of ***My Decomposition Book*** after they read the stories about ***Decomposition in the Forest*** and ***Decomposition at the Coast***.

Suggested Scoring

The Answer Key on pages 63–66 provides the point values for **Breaking It Down—In the Forest** and **Breaking It Down—At the Coast**. Different point values are assigned for correctly labeling different pieces of the cycle.

This variable point system helps indicate which steps of the diagram are more closely tied to the learning objective for the lesson and the purpose of this unit. For example, while being able to label the tree or the worm castings is important, it is more important that students demonstrate that they recognize that decomposers make nutrients available to the tree.



Stories of Decomposition

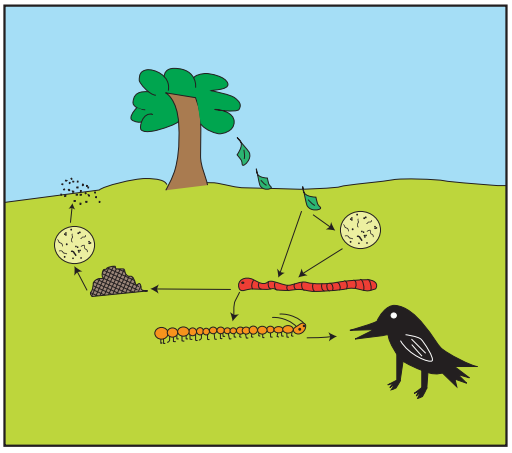
Decomposition in the Forest

A warm wind blows gently through the trees. A leaf falls from a tree to the forest floor. Bacteria from the soil move on to the leaf. They begin to feed on the leaf, breaking it down. As the bacteria get energy and nutrients from the leaf, they reproduce and grow. More bacteria begin to feed on the fallen leaf.

The leaf begins to show signs of decomposing. An earthworm breaking through the top of the soil swallows a piece of the leaf. The earthworm also swallows some soil along with bacteria and fungus living in the soil. The worm's insides grind up the leaf matter. The bacteria living in the worm's intestines help the worm digest the leaf matter. The worm gives off waste called "castings." The castings become part of the soil on the forest floor. Other bacteria and fungi begin to feed on the worm's castings.

They decompose the castings and release the nutrients in them into the soil and air. The tree takes up some of these nutrients in its roots. Plants and animals in the forest breathe in nutrients in the air. The wind blows nutrients to other ecosystems.

A centipede crawling over the fallen leaves sees the earthworm. It catches and eats the worm. Just as the centipede finishes its meal, a bluebird spies it from a tree branch above. The bluebird flies down and snatches the centipede in its beak. Then it flies back up to the branch to enjoy its meal in the warm wind blowing through the trees.

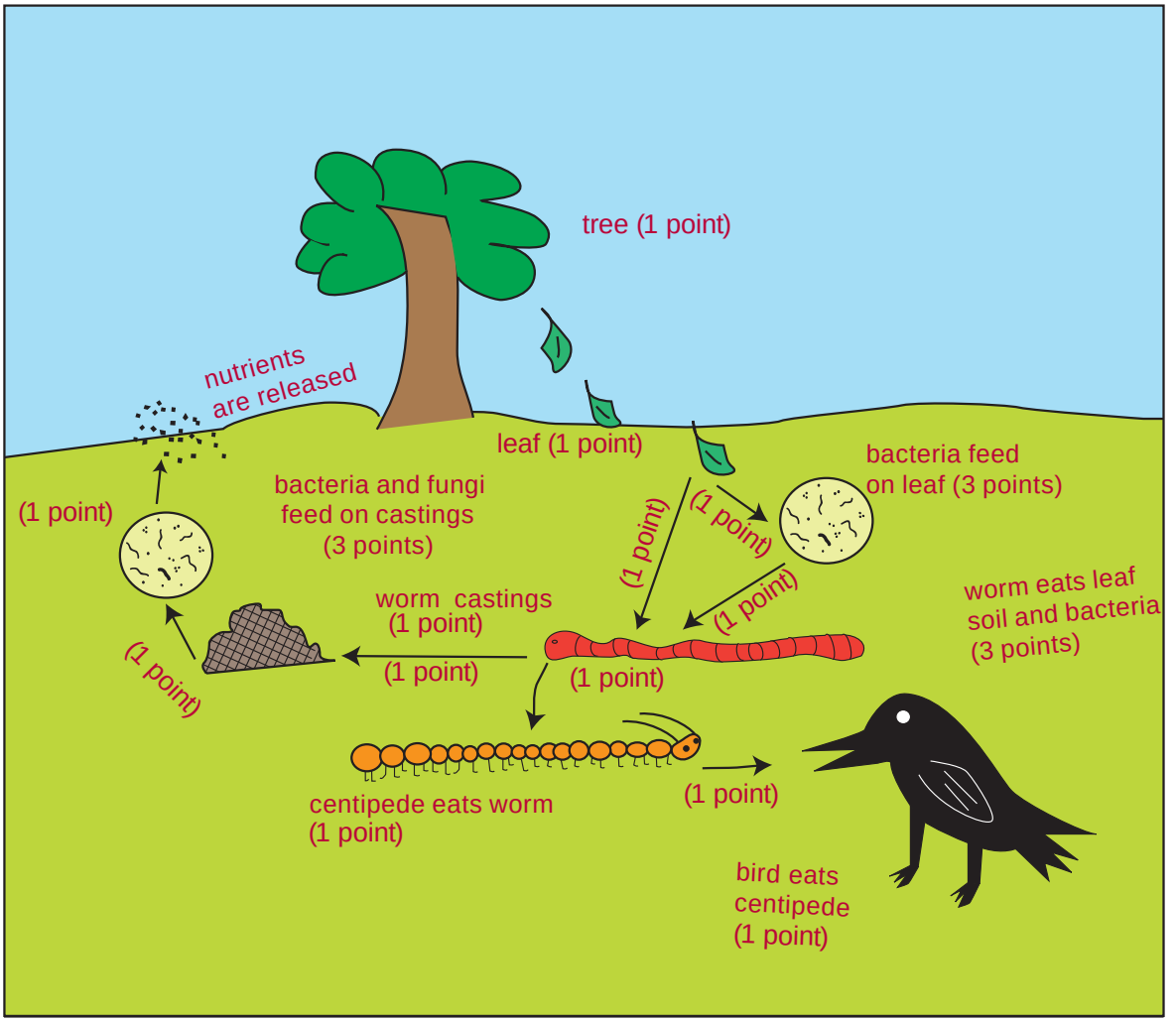


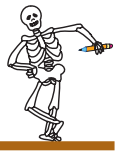
6

Breaking It Down—In the Forest

Use words and arrows to show how the characters in the stories are connected.

Decomposition in the Forest





Stories of Decomposition

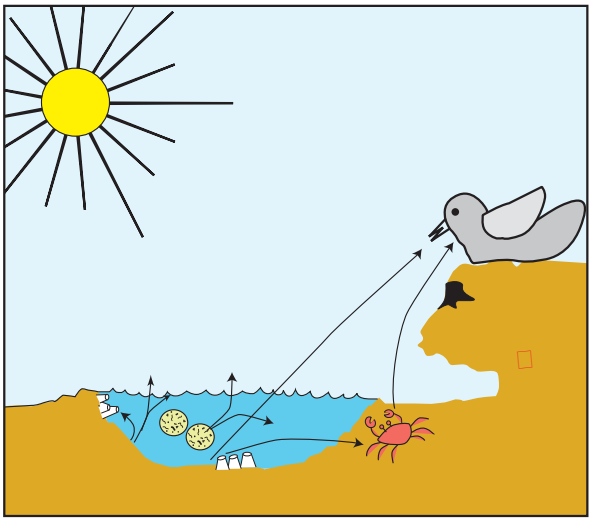
Decomposition at the Coast

As the tide comes in, a crab scampers out from under a rock. It heads over to a pool of ocean water the sun has warmed. It slips into the pool and hides in the slippery, green algae growing on the side.

The algae have been gathering energy all day. The sun and the nutrients in the pool's water are the sources of the energy. Some of the nutrients come from the rocks around the pool. Other nutrients come from the wastes of other animals and plants in the pool. Those animals and plants have been eating and decomposing all day.

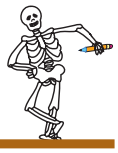
The crab is not interested in the algae right now. It wants the little pieces of a fish that died in the pool earlier. Tiny plankton and barnacles in the pool have already started to feed on the fish matter. But the crab is larger and will use its claws to take some of the fish matter from them.

From the top of the nearby rock, a seagull watches the action in the pool. The gull could eat the dead fish, but the live crab looks much tastier. The seagull steps over its waste on the rock, on which bacteria have already begun to feed. It then hops down to the pool. The crab does not see the seagull's shadow until it is too late.



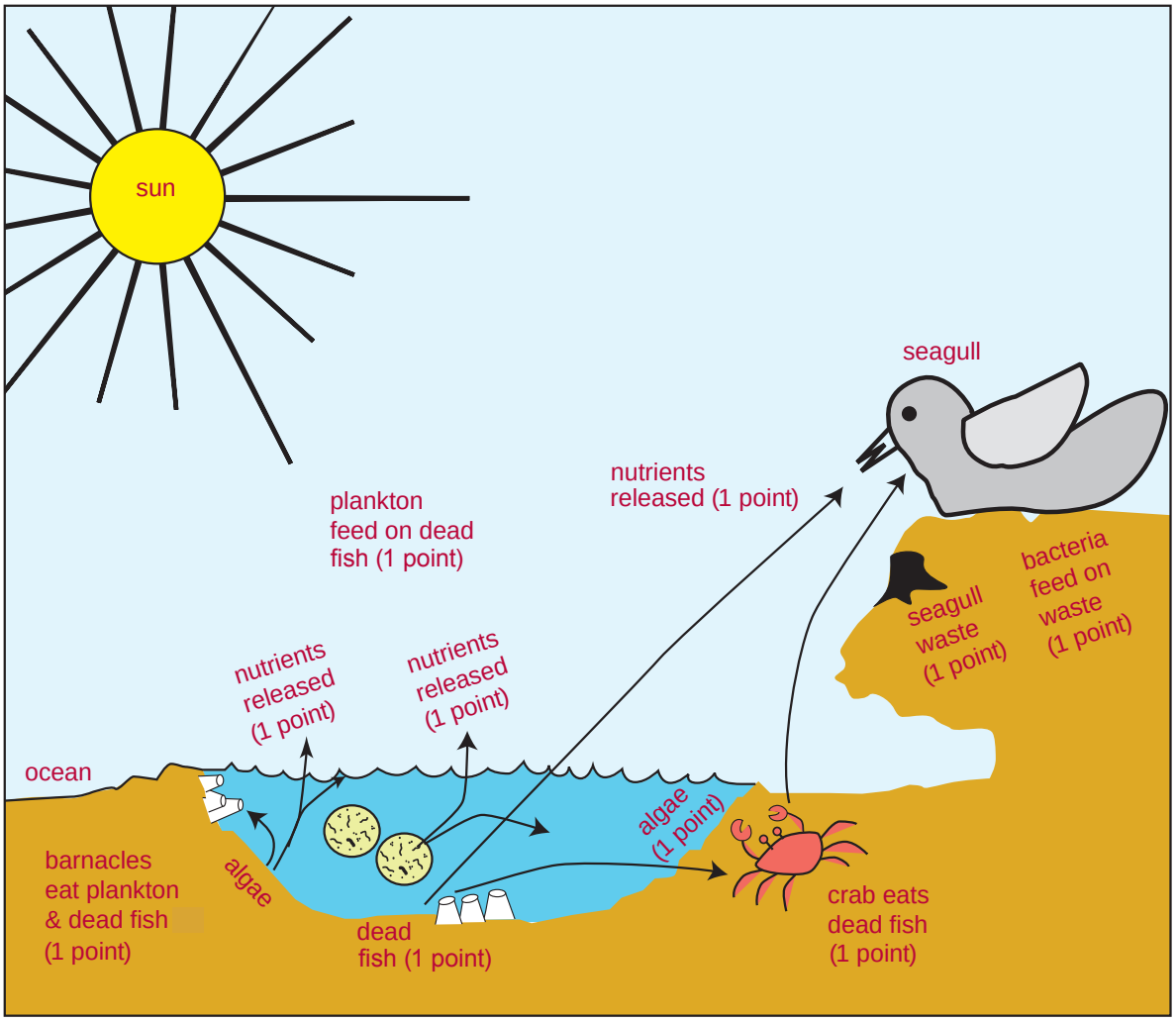
8

Breaking It Down—At the Coast



Use words and arrows to show how the characters in the stories are connected.

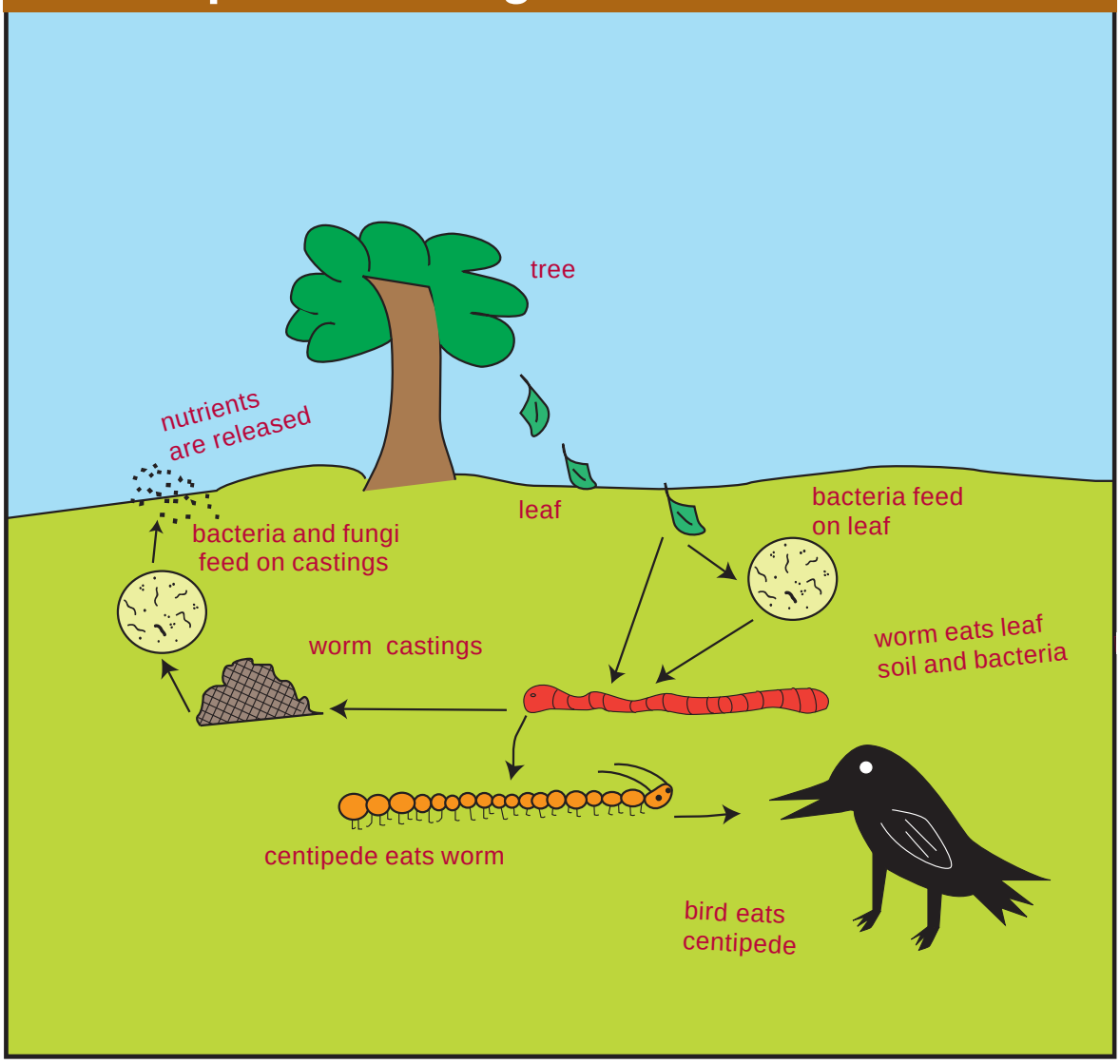
Decomposition at the Coast



9

8 **Decomposition Diagram**
Visual Aid — Transparency

Decomposition Diagram



5 **Evidence of Decomposition**
Visual Aid — Transparency

Evidence of Decomposition

6 **Evidence of Decomposition**
Visual Aid — Transparency

Evidence of Decomposition

7 **Evidence of Decomposition**
Visual Aid — Transparency

Evidence of Decomposition

Lesson 4

Coastal zone

Waste Not

Decomposers play an important role in food webs, but their influence on the planet does not stop there. Throughout this unit, students have become familiar with examples of decomposers, and they have learned that, in their quest to obtain energy, decomposers ensure that nothing in nature is wasted.

Students have also gained understanding of how decomposers return nutrients to all ecosystems, where they help complete the cycles and processes on which all ecosystems depend. Human communities also depend this ability to "recycle" nutrients to help manage their waste streams.

Lesson 4 introduces students to the wastewater treatment system and the involvement of organisms such as plankton and bacteria in waste management. Class discussion enables students to recognize that, whether on land or in a body of water, decomposers are present and necessary to all ecosystems and that humans rely on the health of those ecosystems to ensure that their communities stay healthy.

Learning Objective

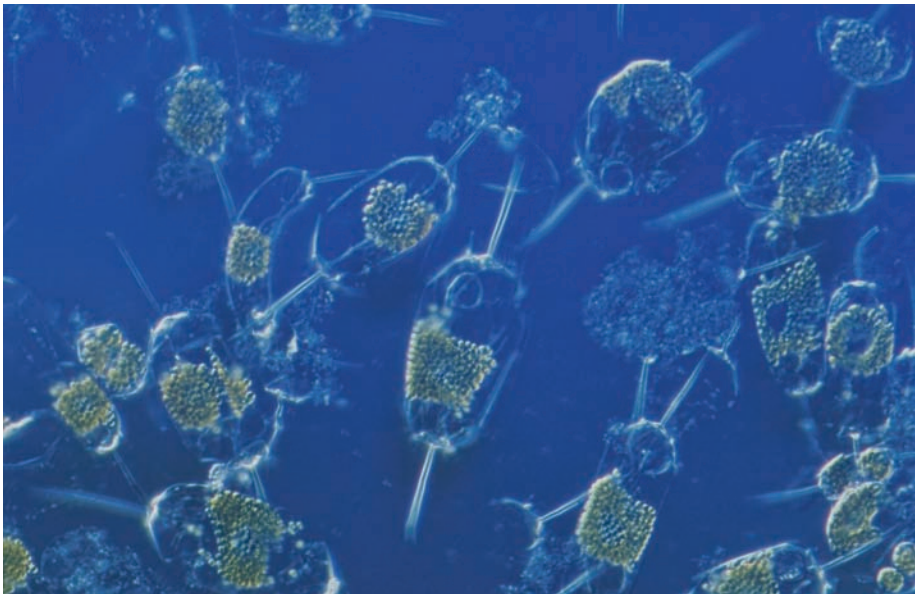
Provide examples of human practices that directly depend on the cycles and processes involving decomposers in terrestrial, freshwater, coastal, and marine ecosystems (e.g., their role in food production and waste management).

Describe the dependence of human practices on the cycles and processes that occur in terrestrial, freshwater, coastal, and marine ecosystems (e.g., the role of decomposers in: food production through soil formation and fertility; waste management through the decay of waste products).

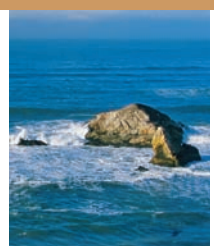
Background

There is no such thing as "waste" in a natural system. All living things need nutrients and energy to live, and everything in a natural system is a source of nutrients or energy (or both) for some organism in the system. As an animal processes food, the body absorbs some nutrients and excretes others. The excretions are still of value, particularly to decomposers that like their food "preprocessed."

While still in the intestines, bacteria go to work on what will eventually be excrement. As they feed, they release carbon, nitrogen, and oxygen from the matter that passes through the digestive tract. The body's cells absorb and use some of these chemicals; the body discharges the rest.



Phytoplankton



"Waste" that has left the body of the animal continues to feed the bacteria present. Other decomposers now join those decomposers, and the "feast" continues. Eventually the decomposers process all of the matter in the excrement, cycling it back into the surrounding environment.

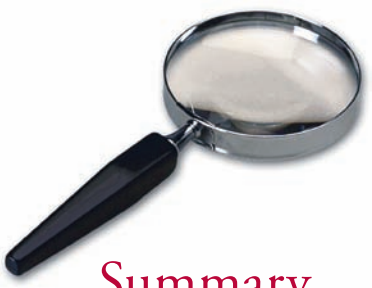
Human communities make great effort to carry away and contain bodily wastes. The bacteria that decompose waste are helpful to humans in our intestines but can be harmful to our health if allowed to infect other parts of our bodies. Humans build complex sewage and wastewater treatment systems that work to keep our communities healthy. But these systems depend wholly upon bacteria and other decomposers continuing to work on the "waste" they collect.

For many communities in California, the ocean is the final step in a city's wastewater treatment process. The "waste" that goes down our drains and toilets travels first to a treatment facility, where bacteria are encouraged to continue decomposing the dissolved organic matter in the wastewater. Then the system pumps the wastewater into a natural body of water, such as the ocean. Bacteria and plankton in the ocean use the nutrients in the remaining organic matter, releasing the nutrients into the surrounding marine ecosystem.

Key Vocabulary

Waste management: The system of collecting, transporting, and processing waste created by humans.

Toolbox



Summary of Activities

Students interpret a diagram showing a wastewater management system. They discuss the presence of particular organisms that help decompose matter in the system. Students answer questions about the waste management system and humans' dependence on decomposers to make the system work.

Instructional Support

See Extensions & Unit Resources, page 30.

Prerequisite Knowledge

Students should have:

- completed previous lessons.

Advanced Preparation

Gather and prepare Materials Needed:

- **My Decomposition Book**

Gather and prepare Visual Aids:

- Prepare transparencies.

Add to Word Wall.

Materials Needed

A-V equipment:

- Overhead or LCD projector, screen

Class supplies:

- Colored pencils (optional), pencils, transparency markers

Visual Aids

Transparencies:

- **Wastewater Treatment Plant**, Visual Aid #9
- **Wastewater Management System**, Visual Aid #10

Duration

Preparation Time
15 min.

Instructional Time
50 min.

Safety Notes

None

Activity Masters in the Supporting Materials (SM)

No Activity Masters are required for this lesson.

Procedures

Vocabulary Development

Use the **Unit Dictionary** and the **Vocabulary Word Wall Cards** to introduce new words to students as appropriate. These documents are provided separately.

Step 1

Distribute students' copies of ***My Decomposition Book***. Instruct students to turn to pages 7 and 9, where they drew diagrams of food webs and decomposers in forest and marine ecosystems.

Ask students, "Where do you see waste in your diagrams?" (*The earthworm castings in the forest; the bird waste on the rock by the tide pool; the dead fish in the tide pool; the fallen leaf on the forest floor.*) "Are these things really waste?" (*No, bacteria or other decomposers feed on the waste, so it is not really "waste."*) "Do you think all waste is useful to some other living thing?" (*Yes, since the waste still contains nutrients, a decomposer can feed on it.*)

Step 2

Point out the new Key Vocabulary term and definition on the word list and have students locate "waste management" on page 10 of ***My Decomposition Book***. Have students read the definition aloud and copy it onto the correct space on page 2. Ask students to name parts of the waste management system that they know. (*Answers will vary but may include recyclables, recycling bins, trash, trash cans, garbage collection, sewer, landfill, dump, and sewage treatment plant.*)

Ask students if they think decomposers break down the "waste" in their community and recycle the nutrients back into the environment. (*Answers will vary.*) Tell students that the waste management system in their community works very hard to make sure that these nutrients are recycled; such systems rely on decomposers to help do this.

Step 3

Display the **Wastewater Treatment Plant** (Visual Aid #9) on the overhead or LCD projector. Tell students that their community has a place like this to help manage the safe decomposition of waste and the cycling of nutrients. These places are "wastewater treatment plants." Explain that many people in their community work in the waste management system, and some work at the wastewater treatment plant. Tell students that decomposers work at these plants too, and that humans could not do their jobs without them.

Step 4

Have students turn to page 10 in ***My Decomposition Book*** and examine the diagram on the page. Place the transparency of the **Wastewater Management System** (Visual Aid #10) on the overhead or LCD projector and walk students through the process using this sequence:

- First, pipes called sewer lines carry away the wastewater created in your home. (Have students find the sewer lines on their copy of the diagram.)
- The sewer lines from each house come together at certain points and the pipes carrying the wastewater get bigger. These large pipes take the wastewater into the wastewater treatment plant. (Have students locate where the sewer lines from the houses come together to form the community sewer line.)
- At the plant, the wastewater goes into a big tank, where it becomes very still. When this happens, anything that is solid sinks to the bottom of the tank. What goes to the bottom of the tank is taken out and put in a special container called a "sludge digester." (Have students locate the settling tanks and the digester in the diagram.)
- The wastewater at the top of the settling tank is drained into big pools called "basins," where air is pumped through the wastewater and chemicals are sometimes added. (Have students locate the aeration basins on the diagram.)
- Then, the wastewater is pumped out of the basins and into a lake, river, or the ocean. (Have students locate the outlet that drains into the larger body of water on the diagram).

Step 5

Ask students to think about where decomposers work in this system. Using a transparency marker, mark the following places in the system shown on the transparency of the **Wastewater Management System**, while students do the same on the diagram on page 10 in their copies of ***My Decomposition Book*.** Explain the following as you mark the diagram:

- Bacteria are everywhere, so decomposers are already breaking down the waste in your home. They travel through the sewer lines in the wastewater, decomposing the waste on the way. (Put a mark on the sewer line coming from the house.)
- In the stillness of the settling tanks at the wastewater treatment plant, the bacteria reproduce and grow, continuing to break down the matter in the water. (Put a mark on the settling tank.)
- In the sludge digester, the people working at the plant help the bacteria to grow. They make the environment in the digester just right for the bacteria to grow and feed like crazy! (Put a mark on the sludge digester.)
- The wastewater that goes into the pools and then into the lake, river, or ocean still has some living bacteria. These bacteria continue to feed on the matter that is contained in the water. Bacteria in the lakes and rivers, or bacteria and plankton in the ocean release the rest of the nutrients back into the environment. (Put a mark on the large body of water.)

Step 6

Ask students, "What would happen if there were no decomposers in this system?" (*The "waste" would not get broken down and would pile up. Nutrients would not be released back into the environment.*) Point out that now they know what happens to the nutrients that made it to the lake, river, or ocean in the wastewater, but what do they think happens to the nutrients in the sludge digester? (*Answers will vary, but may include the idea that the nutrients are probably used somewhere.)* Tell the class that they will learn about those nutrients in the next lesson.

Step 7

Ask students to answer the questions on pages 11–13 in ***My Decomposition Book*.** When they are done, collect students' work to use in assessment.

Lesson Assessment

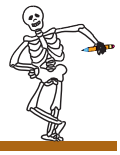
Description

Lesson 4 teaches students that decomposers are essential components of human waste management systems, specifically wastewater treatment systems. Students document decomposers' presence in the system on page 10 in ***My Decomposition Book*** and then answer questions requiring them to describe the dependence of human practices on the decomposition process and nutrient cycle.

Suggested Scoring

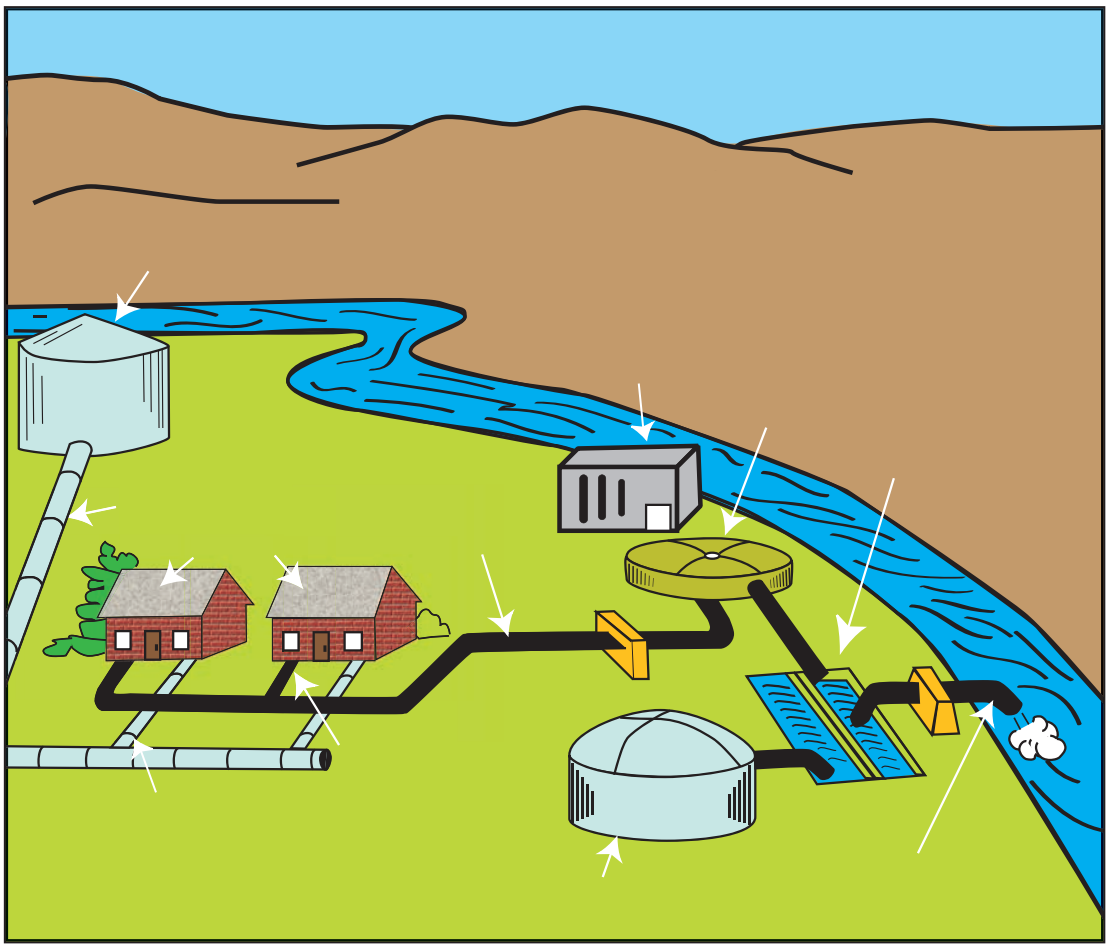
Use the Answer Key and Sample Answers on page 77–78 to assess students' work.

Answer Key and Sample Answers



Our Wastewater Management System

This drawing shows a wastewater management system. Go through each part with your teacher. Then mark where decomposers work in the system.



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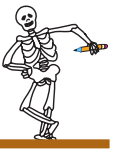


Our Wastewater Management System

We Could Not Do It Without Them!

Think about what you have learned about decomposers and decomposition.

Then answer these questions:

1. How do decomposers help all living things?

They break down waste and help recycle nutrients back into the environment so that other living things can live and grow.

2. How do communities manage waste by using decomposers?

Communities use decomposers to break down the waste from homes. Decomposers work in wastewater treatment plants. Humans put wastewater into lakes, rivers, and the ocean, hoping that the decomposers will break down wastes there.

3. Circle the organisms that are part of the wastewater management system:

mold (bacteria) sea gulls sludge (plankton) scavengers

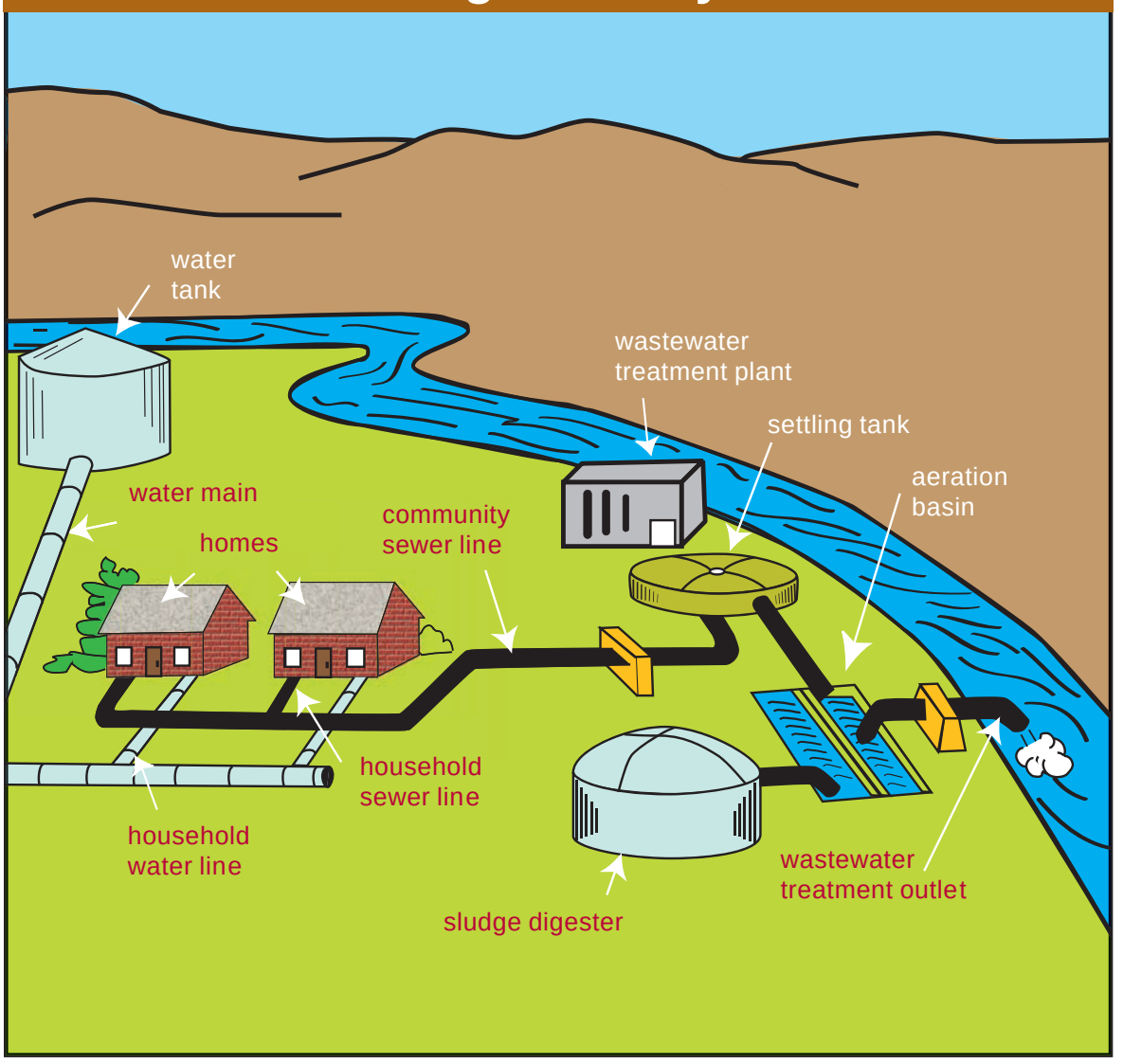
11

9 **Wastewater Treatment Plant**
Visual Aid — Transparency

Wastewater Treatment Plant

10 **Wastewater Management System**
Visual Aid — Transparency

Wastewater Management System



Lesson 5

Farm

Down on the Farm

There are billions of people to feed on this planet; although students may not know it, their diet depends on the work of decomposers. In order for students to grasp how dependent humans are on decomposers, they must understand the connection between productive agriculture and the organic content of soils. Almost all the plant matter humans eat traces back to the topsoil in which it was grown.

In Lesson 5, students encounter the term "humus" and learn how decomposers form humus. Through discussion, they discover how decomposers and the humus they produce influence the fertility of topsoil.

Students work with a partner to analyze different soil samples and determine which sample they think is best suited for growing crops. Finally, students participate in a demonstration that illustrates the limited amount of topsoil available on Earth for agriculture. They apply what they learn from the demonstration to describe the importance of decomposers to our agricultural systems.

Learning Objective

Provide examples of human practices that directly depend on the cycles and processes involving decomposers in terrestrial, freshwater, coastal, and marine ecosystems (e.g., their role in food production and waste management).

Describe the dependence of human practices on the cycles and processes that occur in terrestrial, freshwater, coastal, and marine ecosystems (e.g., the role of decomposers in: food production through soil formation and fertility; waste management through the decay of waste products).

Background

For organisms to proceed through life cycles, they need nutrients. When living organisms die, the nutrients that sustained their lives are still of use. In order for these nutrients to be available for use again, however, they must somehow return to the natural system in elemental form.

Topsoil is the upper layer of soil, characterized by a higher content of organic matter. Due to geography, weather conditions, and urbanization, limited amounts of topsoil are suitable for agriculture. Not all topsoil is of the same quality. Topsoil found in a forest, garden, or desert will display different characteristics. These characteristics determine the soil's fertility. Ultimately, a soil's organic content, or humus, determines its particle size, color, and ability to absorb and retain water, and air. Humus is dark organic material in soil in the very last stage of decomposition. Humus forms as a byproduct of the work done by scavengers and decomposers breaking down dead organisms and releasing nutrients into the soil.

Fertile soil tends to be dark, damp, and rich in humus. Humus helps minerals bond together, creating small spaces in between particles so the soil will retain water and release it slowly. Because humus itself does not stick together well, it helps to loosen the soil, allowing air to move freely to decomposers and plant roots. Sandy soils like those found in deserts tend to be light brown and dry; contain loose, large particles; and drain water quickly. While desert plants are adapted to these soil conditions, many of our food plants are not and this soil cannot be used for agriculture. Soils with high clay content contain small particles that are densely compacted, so they hold water tightly, making accessing the water difficult for plant roots. The most fertile soils contain moderate to high levels of humus, which is a direct link to the health of the vegetation growing there. For this reason, decomposers and the humus they produce are essential to sustaining long-term agriculture practices without the use of chemical fertilizers.

Sprouting plant

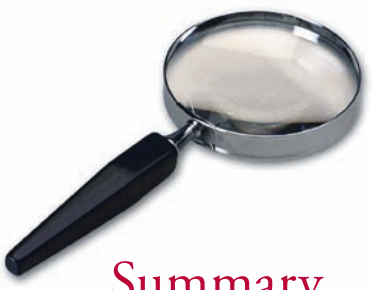
Key Vocabulary

Agriculture: The practice of growing crops and raising animals for food, fiber, or other use by humans.

Humus: The dark brown or black layer in soil that is made up of decaying plants and animal matter. Humus is rich in nutrients and helps hold water.

Topsoil: The upper layer of soil that contains organic matter that helps grow plants.

Toolbox



Summary of Activities

Students learn what humus is and that decomposers form humus as they break down dead organisms. They investigate different soil types and observe the amount of humus in topsoil. They apply their observations to describing why decomposers and humus are essential to agriculture.

Instructional Support

See Extensions & Unit Resources, page 30.

Prerequisite Knowledge

Students should be able to:

- explain that plants are the source
- of all foods.
- state that plants need water and nutrients to grow.
- record simple observations and data.

Advanced Preparation

Gather and prepare Activity Masters.

Gather and prepare Materials Needed:

- **My Decomposition Book**
- Place each soil type in an individual bucket. Write "A" on one index card and "B" on the other. Use tape to label the buckets as follows: The bucket containing sand should be labeled "A"; the bucket containing potting soil should be labeled "B." Place buckets on the floor in a central place.

Gather and prepare Visual Aids:

- Prepare the photo cards of **Topsoil,** making one set for each pair of students.

Add to Word Wall.

Materials Needed

Activity supplies:

- Apple: One per class
- Buckets: Two per class, 1 gallon or bigger (see Advanced Preparation)
- Cups: One per student, at least 16 ounces
- Index cards: Two per class
- Knife: One per class, sharp
- Magnifying glass: One per student
- Measuring cups: Two ½-cup measuring cups (one per bucket)
- Paper towels: Two sheets per pair
- Potting soil: Ten cups of potting soil with high organic content.
- Sand: Ten cups of hygienic sandbox sand

Class supplies:

- Marker, pencils

Visual Aids

Photo cards:

- **Topsoil,** Visual Aid #11

Duration

Preparation Time
30 min.
Instructional Time
50 min.

Safety Notes

Be sure to keep the knife out of reach of students.

Activity Masters

No Activity Masters are required for this lesson.

Procedures

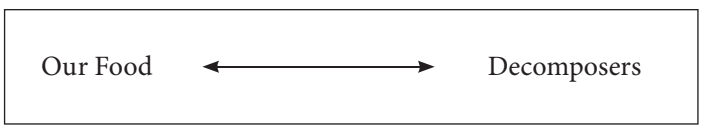
Vocabulary Development

Use the **Unit Dictionary** and the **Vocabulary Word Wall Cards** to introduce new words to students as appropriate. These documents are provided separately.

Step 1

Ask students, "Where does your food come from?" Take answers from several students. (*Answers will vary, but students should note that their food ultimately comes from plants.*) Ask another set of students, "What do plants need to grow?" (*Water, air [carbon dioxide], soil, and sunlight*) Ask a third set of students, "What is soil made of?" *(Organic materials and minerals*)

Draw the following diagram on the board:



Ask students to think about how decomposers connect to growing the food we eat.

Step 2

Distribute students' copies of ***My Decomposition Book***. Point out the three new words on the word list. Read over each word and its definition.

Have students locate "Agriculture," "Humus," and "Topsoil" on pages 1 and 2 of ***My Decomposition Book*** and copy the definitions there. Again, ask students to think about how decomposers connect to growing food.

Step 3

Hold up the apple and tell students that it represents Earth. Cut the apple into quarters, hold up three quarters, and explain that this portion of the apple represents the part of Earth's surface that is covered by ocean water. Hold up the last quarter of the apple and explain that it represents the part of Earth that is not covered by ocean. Tell students that, on this small part of Earth, humans live, work, and grow their food.

Cut the quarter representing Earth's land area in half. Hold up one of the one-eighth pieces, explaining that half of Earth's land area not covered with ocean water has weather conditions so harsh that humans cannot live or grow food there. These are places like the North and South Poles, large deserts, and big swamps.

Hold up the other one-eighth portion of apple, telling students that this represents the part of Earth's surface where people can live and where conditions make growing food possible.

Cut the one-eighth piece into four thin slices. Hold up all four of them, and tell the class that people *live* on this much of the Earth's surface, but cannot grow food on all of it because:

- Some of this area has mountains and hills; the land is too steep to grow food. (Set down one of the four pieces.)
- Some of this area is already covered by our cities, houses, and roads; no room exists to grow food. (Set down another of the four pieces, leaving two.)
- Some of this area does not have soil for growing crops; it is too rocky. (Set down another of the four pieces, leaving one piece held up for students to see.)

Explain to students that this small piece of the whole apple shows how much of Earth's surface is available for growing the food we need.

Carefully peel the skin off this thin slice of the apple, hold it up, and tell students that the tiny peel represents the topsoil available to farmers to grow crops in.

Step 4

Explain that topsoils are made of different materials including sand, clay, and humus. Tell students that topsoils containing lots of humus are very dark in color, smell earthy, and are crumbly. Good topsoil holds lots of water over a long period of time, so plants can use the water as they need it. It also is full of the nutrients that decomposers have released from dead animals and plants. Not all topsoil looks the same, but there are ways to tell what topsoil will help plants grow best.

Tell students they will be acting as teams of soil scientists examining two topsoil samples.

Step 5

Pair students and have the pairs sit together. Pass out the cups, magnifying glasses, paper towels, and a set of photo cards of **Topsoil** (Visual Aid #11) to each pair of students. Have students turn to page 12 in ***My Decomposition Book***. Explain that this page provides instructions students will follow in their work as soil scientists.

Have each pair send up one representative to measure out one-half cup of soil from bucket A into one of their cups and take it back to their table. Have pairs work together to complete the questions for Sample A on page 12 of ***My Decomposition Book***.

When a pair has completed the questions for Sample A, have the other student in the pair come up and measure out one-half cup of soil from bucket B into their other cup and take it back to their table. Have pairs again work together to complete the questions for Sample B on page 12 of ***My Decomposition Book.***

Step 6

Call on students to share the properties of each soil observed by students. Take notes on the board, in T-chart form. (*Sample A is light tan, has large particles, is sandy and rocky, and smells salty, dusty, or sandy. Sample B is light, reddish brown, has pieces that look like sticks and hairs, feels wet and warm, and smells like dirt.*)

Have students think about what they observed and complete the three "Circle an Answer" and questions on page 12–13 of ***My Decomposition Book***. Then tell the pairs to look carefully at the photo cards of **Topsoil**.

Step 7

Ask the pairs to hold up the card with the topsoil that is best for growing crops. Tell students that this would be the soil with the most humus. Ask students, "Which of your soil samples would be best for farming?" (*Sample B*) "Why?" (*Because it has the most humus, which means it has more nutrients and can hold more water than Sample A.*)

Ask students which soil sample would be the most comfortable for an earthworm to live in (*Sample B*) Ask students what this tells them about how decomposers are connected to growing our food. (*Decomposers, like earthworms, make humus. Humus in the soil makes topsoil better for growing plants [crops]. We need good topsoil in which to grow our food. Without decomposers, there would not be humus, which means that the topsoil left on Earth to grow food in would not have the right nutrients or hold enough water for plants to grow in it.*)

Step 8

Have students answer the last question on page 13 of ***My Decomposition Book*** on their own.

As they finish, tell students to collect the topsoil testing materials and the photo cards of **Topsoil** they used and bring them to a central place. The soils can be put back into the buckets they came from and the photo cards gathered to use in the next lesson.

Collect the students' copies of ***My Decomposition Book*** to use in assessment.

Lesson Assessment

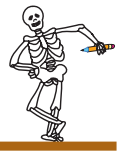
Description

This lesson teaches students that decomposers produce humus and that humus improves soil for use in agriculture. Students' work on page 12 in ***My Decomposition Book*** demonstrates they can identify the work of decomposers in forming humus and describe the dependence of our agricultural system on the process of decomposition.

Suggested Scoring

Use the Answer Key and Sample Answers provided on page 89–90 to assess students' work. **The Testing Topsoil** page is worth 15 points.

Answer Key and Sample Answers



Testing Topsoil

There are many types of soils. You and your partner will look at two types of soil and decide which would be best for farming.

As you look at the two soils, answer these questions:

Sample A: (1 point each)

What color is the soil? *Light tan, white, grey*

What does the soil feel like in your hand? *Dry, loose, rough, heavy*

What does the soil look like under the magnifying glass? *Dry with lots of pieces that look like little rocks*

What does the soil smell like? (Breathe gently.) *Like sand, kind of salty and dusty*

Sample B: (1 point each)

What color is the soil? *Dark brown, almost black and sort of red*

What does the soil feel like in your hand? *Sort of wet, warm, furry, light*

What does the soil look like under the magnifying glass? *Like pieces of wood or chopped up wood, or mud*

What does the soil smell like? (Breathe gently.) *Like dirt and grass, and a little bit like manure*

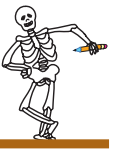
Circle an answer: (1 point each)

Which soil has more humus? **Sample A** **(Sample B)**

Which soil would be best for growing crops? **Sample A** **(Sample B)**

In which soil would you expect to find an earthworm? **Sample A** **(Sample B)**

12



Testing Topsoil

Think and Write:

How do we depend on decomposers in growing our food? (4 points)

Decomposers put nutrients back in the soil. When they break down matter, they create humus that is full of nutrients. The more humus soil has, the more nutrients there are. The best soil for growing crops is soil that has a lot of humus in it.

If there were no decomposers, there would be no humus. Soil without humus has fewer nutrients. We could not grow food in soil without nutrients.

13

Answer Key and Sample Answers

11 **Topsoil**
Visual Aid — Photo Cards

Lesson 6

Cantaloupe growing in compost

The Benefits of Composting

In this final lesson, students examine the role decomposers play in the human practice of composting, which results in two benefits to human communities: maintaining nutrient-rich topsoil and reducing solid waste.

In Lesson 1, students set up a composting demonstration using banana slices and yeast. In this lesson, they revisit their composting samples to note changes in the appearance of the banana slices and in the contents of the two plastic bags. They apply what they now know about decomposers and the decomposition process to identifying what is happening in each bag. Students reread the ***Wonderful Compost*** story and discuss how humans depend on decomposers to manage our solid waste (garbage), reduce our need for more landfill space, and provide nutrient-rich humus to help keep our topsoil healthy. Students conclude the lesson by writing a paragraph about how decomposers are helpful to them and to their community.

Learning Objective

Provide examples of human practices that directly depend on the cycles and processes involving decomposers in terrestrial, freshwater, coastal, and marine ecosystems (e.g., their role in food production and waste management).

Describe the dependence of human practices on the cycles and processes that occur in terrestrial, freshwater, coastal, and marine ecosystems (e.g., the role of decomposers in: food production through soil formation and fertility; waste management through the decay of waste products).

Background

Early in world history, humans realized that decomposers could turn waste products such as manure and fallen leaves into a nutrient-rich fertilizer, eliminating the waste altogether. Composting is the human practice of encouraging decomposition within a controlled environment. The positive results of composting are twofold: humans transform organic wastes into humus or, in this scenario, compost, and they eliminate organic materials from their waste stream.

Composting happens on various scales. On a very small scale, humans can compost a banana slice by placing it in a closed container with yeast. The yeast feeds on the banana slice to obtain its energy, and this process results in the eventual breakdown of the banana slice. More often, humans compost by creating compost bins or piles in their backyards or community and school gardens. Compost bins are closed containers that act as habitats for decomposers. Typically, people place vegetable and fruit scraps as well as yard and garden trimmings in compost bins; this "waste" serves as a food source for scavengers, such as worms, and for decomposers. Some municipalities, many in California, look to composting as a solution to managing their population's organic wastes. Several cities, including San Francisco and Oakland, collect organic material from households, businesses, and schools and haul it to large compost facilities, where decomposers turn it into nutrient-rich fertilizer.

As in nature, the rate at which materials decompose in a compost system and the quality of the compost produced depend on several factors, including the addition of air, water, and types of organic materials. Materials high in carbon and nitrogen provide decomposers with the nutrients they need. Equally important, layering materials or physically turning the materials within a compost system helps oxygen easily reach decomposers. Providing adequate moisture also keeps decomposers healthy and thriving. By meeting the needs of decomposers, humans achieve a cost-effective, responsible waste management system that quickly eliminates waste and produces soil-enhancing humus.

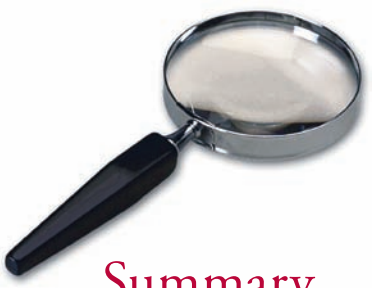
Bulldozer in landfill

Key Vocabulary

Compost: A mix of decomposing plant and animal matter that is used to fertilize soil.

Landfill: A place where solid waste, such as garbage and trash, is buried.

Toolbox



Summary of Activities

Students revisit the composting lab, observing what has happened since they placed the materials in the bags. They reread ***Wonderful Compost*** and discuss how composting can help California communities manage waste and maintain the health of topsoil used to grow food.

Instructional Support

See Extensions & Unit Resources, page 30.

Prerequisite Knowledge

Students should be able to:

- record observations and data.

Advanced Preparation

Gather and prepare Activity Masters:

- Gather students' Activity Masters from previous lessons:
  - **Wonderful Compost** from Lesson 1

Gather and prepare Materials Needed:

- **My Decomposition Book**
- Student composting samples, stored after Lesson 1

Gather and prepare Visual Aids:

- Gather from previous lessons:
  - Photo Cards of **Topsoil** from Lesson 5

Add to Word Wall.

Materials Needed

Class supplies:

- Pencils, scissors, tape

Visual Aids

Photo cards:

- **Solid Waste Management,** Visual Aid #12

Duration

Preparation Time
15 min.
Instructional Time
50 min.

Safety Notes

Students should not open the sealed plastic bags or remove decomposed banana slices from the classroom.

Activity Masters in the Supporting Materials (SM)

No Activity Masters are required for this lesson.

Procedures

Vocabulary Development

Use the **Unit Dictionary** and the **Vocabulary Word Wall Cards** to introduce new words to students as appropriate. These documents are provided separately.

Step 1

Organize students into the groups of four from Lesson 1. Distribute students' copies of ***My Decomposition Book***. Tell students to discuss with their groups the new Key Vocabulary words on the word wall. Tell students to locate the words on page 1 or 2 of ***My Decomposition Book*** and write the definitions next to them.

Step 2

When students have finished writing the Key Vocabulary definitions, ask them to turn to pages 3 and 4 in ***My Decomposition Book.*** Have a few students describe what took place in Lesson 1. (*They put a slice of banana in a bag with yeast [a decomposer] and a slice of banana in a bag by itself; then they predicted what would happen to the bananas in the bags. They drew pictures of what the bags and banana slices looked like. Finally, they stored the bags in a safe place.*)

Tell students that today they are going to re-examine their samples to see what has happened over time. Point out the area where they are to record their observations today.

Stress that students are not to open the bags when they get them back. They should also be careful that the bags do not open accidentally.

Have the student who brought the bags to the storage area in Lesson 1 come to retrieve their group's samples from the storage area and take them back to the group. Have students draw what the bags and samples look like on pages 3 and 4 of ***My Decomposition Book.***

Step 3

Ask students if the samples in the bags have changed. (*Yes*) Ask students what they think has caused the change. (*The bananas have decomposed.*) Ask students if the change is the same in both bags. (*No, the sample with the yeast is different and the bag is full of air [gas].*)

Ask, "What caused the bananas to decompose differently?" (*Yeast, because yeast is a decomposer.*) Tell students that the air (gas) in the bag with the yeast is carbon dioxide, which was released when the yeast broke down the matter of the banana. Students may also see what looks like water in the bag. Water was released during the process.

Note: The bag without yeast will contain bacteria and the non-yeast bag may show some evidence that the banana has decomposed as well. Realizing this, ask students why they think the banana without yeast shows signs of decomposing as well. What could be in the bag (or what might have already been present on the banana) that would have caused the banana to decompose?

Step 4

Distribute the copies of ***Wonderful Compost*** (Lesson 1 Activity Master) and read the article aloud as a class.

Ask students what would have happened to the food scraps in the article if there were no decomposers in the compost bin. (*The food scraps would not have decomposed and would have piled up.*) Ask students what they think would have happened to the banana slices in their lab if decomposers did not exist. (*They wouldn't have decomposed.*) Have students explain what the decomposers in the narrative and in the banana lab both did for humans. (*They broke down waste left by humans.*) Ask students to cite another way the humans in the ***Wonderful Compost*** story depended on the work of the decomposers. (*The decomposers created compost for the humans to use in their garden to help grow more food.*)

Step 5

Tape the photo cards of **Topsoil** (Visual Aid #11) in the Central Valley and the photo cards of **Solid Waste Management** (Visual Aid #12) on the board.

Explain that human communities in California produce a lot of solid waste, such as food scraps and yard trimmings, and that some cities dump this waste in landfills while others compost it. Like the people in the article, California cities that compost find that composting can reduce the amount of garbage in the landfill. Composting also produces humus (sometimes called "compost") that can be used to improve soil for agriculture.

Step 6

Point to the photos taped on the board. Ask students to describe how decomposers are important to the practices in these pictures—agriculture and waste management. Write student responses next to each photo. (*Decomposers make humus that is needed in topsoil to grow crops. Decomposers help compost garbage so that our landfills do not fill up and communities stay clean.*)

Step 7

Have student turn to page 14 in ***My Decomposition Book*** and answer the questions with the help of their group members. While students are working, collect the plastic bags and composting samples carefully.

When students are done, have them place ***Wonderful Compost*** inside their copies of ***My Decomposition Book*** and collect them to use in assessment.

Lesson Assessment

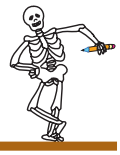
Description

In this lesson, students learn how composting involves decomposers in solid waste management. After recording their observations of the composting samples begun in Lesson 1, students identify composting as one example of a human practice that relies on the process of decomposition; they describe how humans depend on the work of decomposers in agriculture and managing waste by answering the questions on page 14 in ***My Decomposition Book*.**

Suggested Scoring

Use the Answer Key and Sample Answers on page 99 to assess students' work.

Answer Key and Sample Answers



What Decomposers Do for Me

You have learned many things about decomposers. In the space below, write about how decomposers help you and your community.

Use the following words in your writing:

decomposition	humus	crops
compost	garbage	landfill
nutrients	matter	grow

Decomposers are the organisms that make decomposition happen. They break down matter. The humus they make puts nutrients back into the soil. Humus in the soil helps crops grow; crops produce the foods we eat. Decomposers also can help compost my garbage so that it does not go into the landfill. Then landfills do not get so full, and we do not need so many of them. Humus made in the composting can be used to make the soil better for growing crops.

14

12 **Solid Waste Management**
Visual Aid — Photo Card

Credits

Editing Credits

Instructional Editors	Jayne C. Henn
Copy Editors	Laurel Singleton
Photo Editor	Jovi Radtke, Uptown Studios
Proof Reading	Michael D. Lieberman

Design and Production Credits

Original Design	Karol A. Keane, Design & Communications, Inc./National Geographic Society
Graphic Production	José Munguia, Creative Services, California State University, Sacramento
Printing	Graphic Communication Institute, Cal Poly, San Luis Obispo

Content and Educational Reviewers

Content	Lori Whalen, M.A.

Illustration Credits

Page 24	Decomposition on a farm – José Munguia, Creative Services, California State University, Sacramento
Page 63	Decomposition in the Forest – José Munguia, Creative Services, California State University, Sacramento
Page 64	Decomposition in the Forest – José Munguia, Creative Services, California State University, Sacramento
Page 65	Decomposition at the Coast – José Munguia, Creative Services, California State University, Sacramento
Page 66	Decomposition at the Coast Diagram – José Munguia, Creative Services, California State University, Sacramento
Page 67	Decomposition Diagram – José Munguia, Creative Services, California State University, Sacramento
Page 77	Our Wastewater Management System – José Munguia, Creative Services, California State University, Sacramento
Page 80	Wastewater Management System – José Munguia, Creative Services, California State University, Sacramento

Photo Credits

Cover	Vermicomposting – Suzanne Carter-Jackson/iStockphoto
Page 4	Springtails on an upturned mushroom – Darlyne A. Murawski/National Geographic Society
Page 6	Apple tree – Lya Cattel/iStockphoto
Page 7	Apple core – Achim Prill/iStockphoto
	Apples in compost pile – Nathan Watkins/iStockphoto
Page 8	Red worms feeding – Suzanne Carter-Jackson/iStockphoto
Page 9	Nematode in a compost heap – Bianca Lavies/National Geographic Society
Page 10	Leaves and mushrooms on forest floor – George Grall/National Geographic Society
Page 11	Turkey vulture – Cay-Uwe Kulzer/iStockphoto
Page 12	Estuary near Ventura, CA – Rich Reid/National Geographic Society
Page 13	Farm crops – Jim Richardson/National Geographic Society
Page 29	Sow bugs in compost – Bianca Lavies/National Geographic Society
Page 30	Path into the woods – Kip Evans Photography
Page 32	Cantaloupe sprouting in compost – Bianca Lavies/National Geographic Society
Page 33	Microscopic bread mold – Tina Carvalho/MicroAngela
	Compost bin – Foto Pfluegl/iStockphoto
Page 44	Red velvet mites – Beverly Joubert/National Geographic Society
Page 45	Mushroom on forest floor – Klaus Nigge/National Geographic Society
	Leaf eaten by scavengers – Peter Essick/National Geographic Society

Photo Credits (continued):

Page 52	Bacteria – Jane Hurd/National Geographic Society
	California condor – Kip Evans Photography
Page 53	Earthworm – Kip Evans Photography
	Mold – Brian Gordon Green/National Geographic Society
Page 54	Mushroom – Klaus Nigge/National Geographic Society
	Millipede – Joel Sartore/National Geographic Society
Page 55	Blowfly – Robert Clard/National Geographic Society
	Pill bug – Bianca Lavies/National Geographic Society
Page 56	Leaves on forest floor – Phil Schermeister/National Geographic Society
Page 57	Remains of a dead animal – John Eastcott & Yva Momatiuk/National Geographic Society
	Caterpillars eating leaves – Hadi Djunaedi/iStockphoto
Page 68	Meat and bones – Bill Hatcher/National Geographic Society
	Vegetables – Chet Mitchell/iStockphoto
	Wood – Darlyne A. Murawski/National Geographic Society
	Bread – Brian Gordon Green/National Geographic Society
Page 69	Leaf – Peter Essick/National Geographic Society
	Fruit – Jessica Jones/iStockphoto
Page 70	Coastal zone – Marc Moritsch/National Geographic Society
Page 71	Wastewater treatment plant – Ann Akesson/iStockphoto
	Phytoplankton – Bill Curtsinger/National Geographic Society
Page 79	Wastewater Treatment Plant – Kip Evans Photography
Page 81	Phytoplankton – Norbert Wu/Minden Pictures/National Geographic Society
Page 82	Farm – Priit Vesilind/National Geographic Society
Page 83	Rows of farm crops – Rich Reid/National Geographic Society
	Sprouting plant – Oiver Hoffmann/iStockphoto
Page 91	Topsoil of the Central Valley – Scott Leigh/iStockphoto
	Topsoil of the Southern California Badlands – Jonathan Ling/iStockphoto
Page 92	Cantaloupe growing in compost – Bianca Lavies/National Geographic Society
Page 93	Vermicomposting – Suzanne Carter-Jackson/iStockphoto
	Bulldozer in landfill – Pete Ryan/National Geographic Society
Page 100	Landfill – Pete Ryan/National Geographic Society
	Large Compost Facility – Kansas State University, Research and Extension

California Education and the Environment Initiative